Vol. 17, No. 2 February ,1961

LUBRICATION ENGINEERING

DESIGN RESEARCH APPLICATION EDUCATION MAINTENANCE

See page 72 for...

Lubrication in Space

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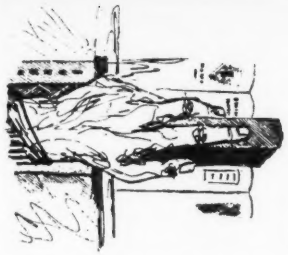

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Volume 17, No. 2
February, 1961

Lubrication Engineering

DESIGN RESEARCH APPLICATION EDUCATION MAINTENANCE

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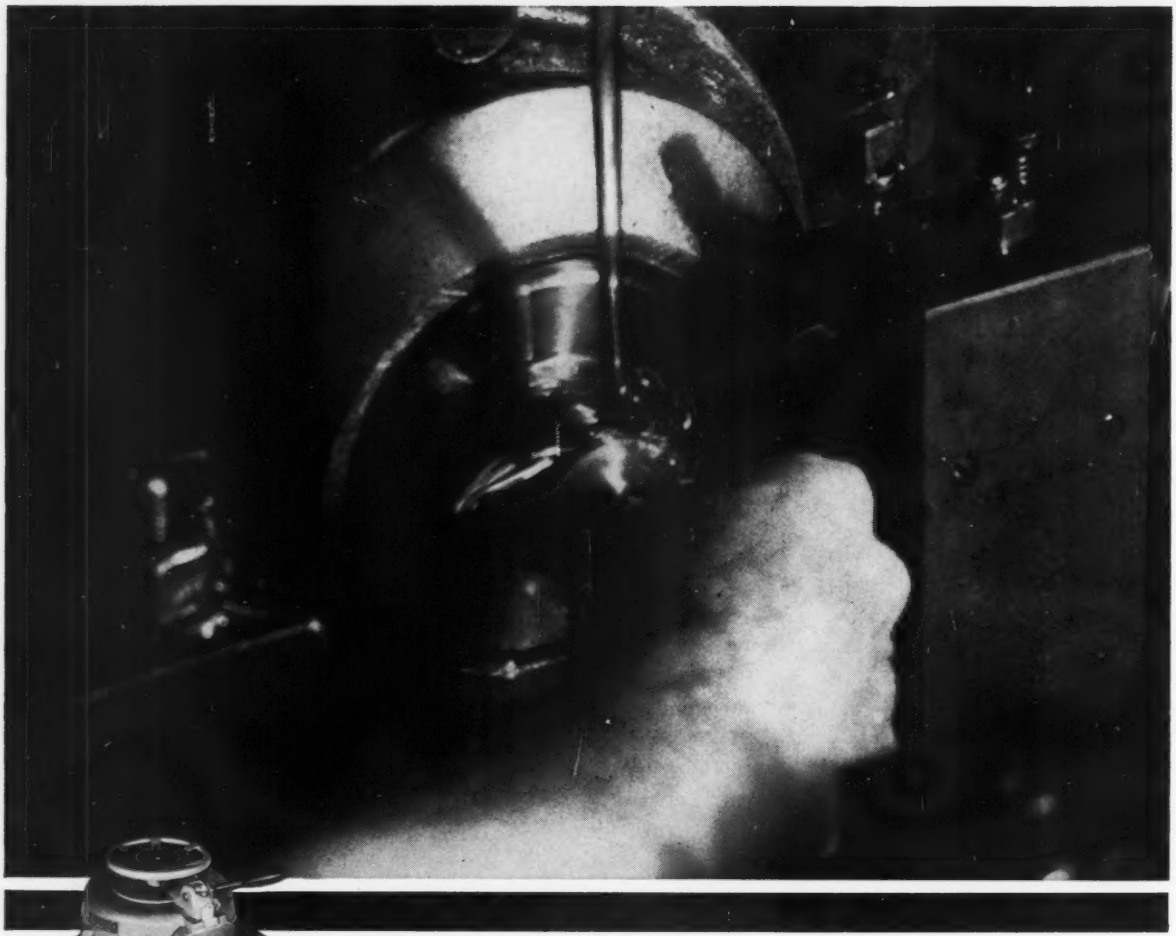

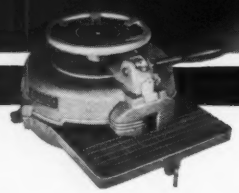

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LUBRICATION IN THE NEWS

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ASTM COMPILES STANDARDS ON PETROLEUM PRODUCTS AND LUBRICANTS

The 1960 edition of the ASTM Compilation of Standards on Petroleum Products and Lubricants contains 168 standards of which some 31 are new, revised, or have had their status recently changed. The standards have been prepared by ASTM Committee D-2 on Petroleum Products and Lubricants. The Compilation is being published in two volumes for the first time.

Volume I will contain most of the ASTM standards on petroleum including crude petroleum, butadiene, motor and aviation fuels, naphthas, diesel fuels, lubricating oils, industrial oils, cutting oils, turbine oils, greases, waxes, spray oils, and other related materials.

Petroleum chemists and technologists, engineers, and purchasing agents will find this compact volume handy in their daily work.

This is the 37th annual edition of the Compilation which includes methods of testing, specifications, definitions, charts and tables. The volume contains 11 extensive appendices containing proposed methods. Typical of some of the new standards included in the book are: Water and Sediment in Fuel Oils by Centrifuge; Luminometer Numbers of Aviation Turbine Fuels; Refractive Index of Viscous Materials; and Oil Separation from Lubricating Grease During Storage.

It is hoped that Volume II will be available during the early months of 1961. It will include a number of standards prepared by other ASTM Committees which are related to those in Volume I and used in the petroleum industry.

Copies of this book may be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. at $9.50 each. (Source: American Society of Testing Materials).

RESEARCH SCIENTISTS, ENGINEERS NOW DOUBLE

Scientists and engineers engaged in chemical industry research have more than doubled in the past nine years.

Now estimated by the National Science Foundation at approximately 34,000, as of January 1959, only 15,632 were employed in 1950, according to a survey by the National Research Council. At the same time the number of research technicians has grown at nearly the same rate—16,941 in 1950 compared to 34,400 today, according to these same sources.

Representative chemical companies currently appropriate three to four per cent of their annual sales for research.

Broken down by category, the chemical industry, as of January 1959, employed 36,600 engineers, 31,100 chemists, 4,200 medical scientists, 3,900 biological scientists, 1,600 agricultural scientists, 1,200 physicists, 700 metallurgists, 600 mathematicians, 300 geologists and geophysicists, and 3,000 other scientists. (Source: Chemical News, Nov.-Dec., 1960)

FRANKLIN INSTITUTE LABORATORIES AWARDED CBBI HYDROSTATIC LUBRICATION RESEARCH CONTRACT

Franklin Institute Laboratories for Research and Development, Philadelphia, has been awarded a contract to explore hydrostatic lubrication in its relation to cast-sleeve bearings.

Carter N. Paden, Jr., President of the Cast Bronze Bearing Institute (a product group of the Non-Ferrous Founders' Society) explains the problem: "In applications where speeds are low and loads high, hydrodynamic lubrication may be impossible. When this is true and full-fluid-film lubrication with no metal-to-metal contact is desired, hydrostatic lubrication may be used to great advantage."

The information obtained from this new research program will be used to expand the hydrostatic lubrication section of the CAST BRONZE BEARING DESIGN MANUAL, which was originally prepared by the Franklin Institute under the auspices of CBBI. In the present CBBI Manual, some of the very concrete advantages of using hydrostatic lubrication in combination with superior bearing bronze was pointed out, but no practical information for designing was given.

Under the current research program the following information will be developed:

A. Principles of hydrostatic lubrication.
B. Load carrying capacity.
C. Flow pressure and power requirements.
D. Design and fabrication.
E. Compensation of hydrostatic bearings.
F. Power required to overcome friction.
G. Resulting lubricant film stiffness.
H. Initial lift.
I. Sample problem of analysis and design.

As this new information becomes available, it will be released as a separate publication and at a future date will be incorporated in a revised edition of the CAST BRONZE BEARING DESIGN MANUAL. (Source: Cast Bronze Bearing Institute, Inc.)

RUSSIAN RUBBER LITERATURE TRANSLATIONS AVAILABLE FROM OTS

Translations of Soviet technical literature on rubber have been released for sale to the public through the Office of Technical Services, Business and Defense Services Administration, U. S. Department of Commerce, Washington, D. C. They are:

60-41433—*The Effect of Rubber Hardness on the Coefficient of Static Friction Without Lubrication.* September 1960, 8 pages, 50 cents. Translation of Akademiya Nuak USSR, Doklady, 1954. S. B. Ratner and V. D. Sokol'skaya.

60-41434—*Effect of Rubber Fillers on the Coefficient of Static Friction.* September 1960, 7 pages, 50 cents. Translation of Akademiya Nuak USSR, Doklady, 1952. S. B. Ratner and V. D. Sokol'skaya. (Source: United States Department of Commerce)

(Continued on page 61)

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$$V = \frac{gD^2 (d_1 - d_2)}{18\eta}$$

where g is the gravitational constant, D the Stokes' diameter of the suspended particles, d_1 and d_2 the respective densities of the dispersed material and the dispersion medium, and η the viscosity coefficient of the dispersion medium. Since settling rate varies as the square of Stokes' diameter, half-micron particles will theoretically remain suspended 400 times longer than ten-micron particles.

The suspension characteristics of well-stabilized colloidal dispersions are actually better than Stokes' Law would indicate. This is due to the increasing power of inter-particle kinetic forces to overcome gravity and allow Brownian movement when particle sizes are reduced to below one micron. A sample of 'Oildag'® tested recently after having been in storage for forty years was found to be in perfect condition!

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1961

Annual Short Course in

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Emphasizing Preventive Maintenance

Sponsored by the ASLE Education Committee

Chairman: M. E. Dougherty, Acheson Colloids Co., Philadelphia, Pa.

To be held concurrently with the Technical Sessions at the Annual Meeting April 11, 12, 13, 1961 at the Bellevue Stratford Hotel, Philadelphia, Pa.

All sessions will be held in the Clover Room

Tuesday, April 11, 1961

9:00 a.m.–12:00 noon–
LUBRICATION FUNDAMENTALS

Introduction:

Lee. O. Witzenburg, President, ASLE, The Cleveland Worm and Gear Div., Eaton Mfg. Co., Cleveland, Ohio

The purpose of the course and a short discussion of the aims and ideals of ASLE.

Fundamentals of Lubrication:

Dr. Gordon B. Weld, Nova Scotia Technical College, Halifax, Nova Scotia, Canada

Some of the basic principles of lubrication will be covered by lecture and demonstrations using models for illustration.

Boundary Lubrication:

Dr. M. Eugene Merchant, Director of Physical Research, The Cincinnati Milling Machine Co., Cincinnati, Ohio

When a fluid film of lubricant is unable to exist to keep two moving surfaces from contact, boundary lubrication must be depended upon to keep friction, wearing and scoring at a minimum.

Thick Film Lubrication:

Fred Hanly, Research Engineer, California Research Corporation, Richmond, California

Subjects treated include: influence of friction under dry and lubricated conditions; development of the tapered oil film and its effect on friction in pivoted pad and journal bearings; oil film pressure and grooving; sparse lubrication; and principle of hydrostatic lubrication and its applications. Film.

Tuesday, April 11, 1961

1:00 p.m.–5:00 p.m.–LUBRICANTS

Lubrication Engineer's Manual: Distribution–Discussion

William E. Hamilton, Lubrication Eng., Tennessee Coal & Iron Div., U. S. Steel Corp., Fairfield, Ala.

Properties of Lubricants:

Ray Gunther, Lubrication Engineer, Mobil Oil Co., Paulsboro, New Jersey

Lecture will include methods of measuring properties of lubricants. Factors which influence lubricant performance will be treated including conditions that lead to failure and analyses of such failures.

Application of Lubricants and Maintenance of Lubricating Equipment:

W. Shinn, Lubrication Engineer, U. S. Steel Corp., Fairless Works, Fairless Hills, Pa.

A discussion of the various methods and equipment

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for handling and dispensing bulk lubricants, centralized systems, oil circulating systems and maintenance problems in connection with this type of equipment.

Solid Lubricants and New Ideas on Dry Films:

A. Sonntag, President, Alpha Molykote Corp., Stamford, Connecticut

The use of solid lubricants in liquid media will be discussed. Properties of graphite, molybdenum disulfide and TFE resin will be pointed out and demonstrated by slides. Theory of thin film solid lubricants will be briefly talked about, and use of dry film in practice will be illustrated.

Tuesday, April 11, 1961

7:30 p.m.–9:00 p.m.–LATE SESSION

Film Presentations:

1—"Grease—The Magic Film"—National Lubricating Grease Institute underscores the importance of lubricating greases in this modern world.

2—"Before Hydraulic Fires Start"—Monsanto Chemical Company. This film demonstrates the importance of fire resistance hydraulic fluids and the hazards encountered when they are not used.

3—"Machines—Their Care and Feeding"—Sun Oil Company

4—"Service Procedure for Ball Bearings"—New Departure Division, General Motors Corp.

Wednesday, April 12, 1961

PLANT VISITATION

(Busses will leave Broad St.–Wednesday 8:00 a.m.)

TOUR A–Franklin Institute Laboratories, Philadelphia, Pennsylvania

(This will be limited to the first sixty signing for this tour)

9:00 a.m.–12:00 Noon

Design Aspects of Fluid Film Lubrication:

I–Hydrostatic:

Dr. D. D. Fuller, Columbia University, New York Franklin Institute, Philadelphia, Penna.

II–Hydrodynamic:

Harry C. Rippel, Friction and Lubrication Branch, Franklin Institute, Philadelphia, Penna.

An Expert Looks at Friction and Wear:

Dr. W. E. Campbell, Consultant, Cleveland, Ohio

Lunch

Tour of the Franklin Institute Laboratories

TOUR B–U. S. Steel Corp., Fairless Works, Fairless Hills, Pennsylvania

(This will be limited to the first one-hundred and fifty signing for this tour)

9:00 a.m.–12:00 Noon

A Lubrication Engineer Looks at Bearings, Bearing Problems and Bearing Lubrication with Emphasis on Preventive Maintenance:

T. Herbert Freeman, Lubrication Engineer, Lukens Steel Company, Coatesville, Penna.

Discussion will include some of the common causes of trouble in bearing lubrication with emphasis on preventive maintenance.

A Lubrication Engineer Looks at Gears, Gear Problems and Gear Lubrication:

Don Saylor, Lubrication Engineer, Alan Wood Steel Company, Conshohocken, Penna.

Gear lubrication will be discussed with emphasis on preventive maintenance

Lunch

Tour of the U. S. Steel Fairless Works

Thursday, April 13, 1961

8:30 a.m.–12:00 Noon

A Lubrication Engineer Looks at Seal, Packing and their Lubrication with Emphasis on Preventive Maintenance:

Dr. George Schmidt, Manager Technical and Research Development, Crane Packing Co., Morton Grove, Ill.

A survey of this field covering mechanical seals, gaskets, packing and stuffing boxes and their lubrication with emphasis on preventive maintenance.

A Lubrication Engineer Looks at Seal, Packing and their Lubrication with Emphasis on Preventive Maintenance:

Henry Shortly, Lubrication Engineer, Western Electric Company, Baltimore, Maryland

All phases of hydraulic fluid, performance and lubrication with emphasis on preventive maintenance.

Plant Lubrication and Organizing a Plant Lubrication Program:

C. L. Pope, Eastman Kodak Co., Rochester, N.Y.

Lubrication as it affects various people in an industrial plan. The role of a plant lubrication engineer in organizing a plant lubrication program with emphasis on preventive maintenance.

Thursday, April 13, 1961

1:30 p.m.

Lubrication Symposium–Question and Answer Panel

Moderator–Marco Petronio, Pitman-Dunn Laboratory, Frankford Arsenal, Philadelphia, Penna.

Course Lecturers on Panel

William Eisman, Jr., E. F. Houghton and Co., Philadelphia, Penna., and Martin J. Devine, Aeronautical Materials Laboratory, Naval Air Material Center, Philadelphia, Penna.

M. E. Dougherty, Chairman, anticipates a record enrollment, therefore, enrollments will be handled on a first come–first served basis. Fill out the registration form on the other side. Clip and mail (with check attached) to Herman H. Klug, Engineering Department, Scott Paper Co., Market Street, Chester, Pa. Make checks payable to ASLE.

LUBE IN THE NEWS

(Continued from page 57)

THE AMERICAN ROCKET SOCIETY AND NORTHWESTERN UNIVERSITY ANNOUNCE GAS DYNAMICS SYMPOSIUM

The fourth Biennial Gas Dynamics Symposium to be held at Northwestern University on August 23-25, 1961 has been jointly announced by the American Rocket Society and Northwestern University.

The scope of the program tentatively includes: Transport Properties of Plasmas, Magnetohydrodynamic Wave Phenomena, Experimental Techniques and Observations, Propulsion, Power Generation, Magnetohydrodynamic Flows, Thermodynamic Properties of Plasma. (Source: Northwestern University).

FOUR SHORT COURSES ON CORROSION SCHEDULED BY NACE

Four short courses on corrosion sponsored or endorsed by National Association of Corrosion Engineers will be presented during the first six months of 1961. Two courses will be presented in February and two in June.

Houston Section NACE corrosion short course was held February 2-3. Subjects considered along with the men who directed discussion are: corrosion control in transmission pipe line systems, M. E. Frank, Tennessee Gas Pipeline Co.; corrosion in oil and gas production, J. T. Payton, Texaco, Inc.; corrosion in refineries and chemical plants, C. L. Woody, United Gas Corp.; and corrosion in commercial and residential construction, M. A. Riodan, Rio Engineering Co. (Source: National Association of Corrosion Engineers)

GERMANS REPORT ALKALI PHOSPHATE LUBRICANTS EFFECTIVE FOR HOT METAL FORMING

In a talk before a conference of the West German Lubrication Society recently, Dr. George Graue and Dr. Inge Werner Luckerath, both of the Metallurgical Department of Phoenix-Rheinrohr AG, reported that certain phosphate systems provide a tenacious boundary lubricant which retains its lubricity at extreme temperatures and high pressures. These lubricants were developed in West Germany and are recommended for use at temperatures of from 1100° to 2200°F. One of them has recently been introduced in the United States and Canada by the Alpha-Molykote Corp., Stamford, Conn., under the trade name PHOSPHATHERM RN.

The West Germans' report increased tool life and reduced tool removal pressures in the piercing of seamless tubing by application of the new lubricant. Mandrel life was increased from 5 to 50 billets and the pressure required to remove the mandrel from the formed billet was reduced from nearly 3,000 psi to from 200 to 900 psi. Similar results are reported to have been obtained in other hot forming operations.

According to Graue and Luckerath the basic system, $Ka/Na/P_2O_5$, provides a water soluble melt which softens at high temperature. As temperature rises the viscosity of the melt drops evenly and steadily. The solidified liquids do not crystalize readily after cooling. Any excess of the cooled lubricant is soluble in water except for the actual phosphate layers which are easily removed in ordinary pickling baths.

The lubricant and its variations can be used as a dry powder but solutions are easier to apply. After evaporation of the water under high temperatures a well wetting adhesive lubricant film forms on both the work piece and tool. This film retains load-carrying capacity under extreme pressures because it forms a phosphate boundary layer on the metal surface. The lubricant was initially tested by the West German Petroleum Research Institute at Hannover. (Source: The Alpha-Molykote Corp.)

KAYDON DEVELOPS RESEARCH STUDY ON ANTI-FRICTION BEARINGS

The first complete research study on large diameter anti-friction bearings has been released by The Kaydon Engineering Corp., Muskegon, Michigan. The new 227-page book is titled, Feasibility Study of Large Diameter Anti-Friction Bearings for Radar Antenna Applications, developed by Kaydon's engineering department under a research and development contract from the Massachusetts Institute of Technology, Lincoln Laboratory, the study provides a comprehensive reference for bearing designers, designers of radar antennas and other applications using large bearings, and those interested in the art of mechanical engineering.

The study summarizes the present state of the art of large bearing design, including detailed discussion, formulas, and other specific data on all types of ball and roller bearings. It investigates the methods for obtaining bearings having the maximum load-life capacity for support systems such as those needed for very large rotating antenna systems.

Theoretical studies include three papers: "Elastic Analysis of Internal Load Distribution in Large Diameter Anti-Friction Thrust Bearings", "Stiffness Characteristics of Large Diameter Anti-Friction Bearings", and "Static Capacity Criteria Review".

These theoretical investigations propose a new method of analysis to take into account the elasticity of bearings race rings and supporting structure when determining the load and stress distribution within a bearing under thrust loading.

A static capacity criteria review points out the discrepancies in the use of Hertzian equations to determine stress levels in the plastic range of stress, with suggestions for a new criterion upon which static capacity might be based. (Source: Kaydon Engineering Corp.)

INDUSTRY NOTES

—One out of four engineers in industry believes that engineers are thought of as second class professionals, but no industrial managers agree with this opinion.

—Sixty-one per cent of the engineers employed in industry think there is considerable mal-utilization of engineers, but only 30 per cent of industrial managers agree.

—More than half the engineers in industry think that higher pay would advance the engineering profession, but only 20 per cent of industrial managers agree.

These are some of the findings reported in a survey entitled "Engineering Professionalism in Industry" made under the sponsorship of the Professional Engineers Conference Board for Industry, in cooperation with the National Society of Professional Engineers.

The survey, the sixth in a series made for the Conference Board, is now available in booklet form from the National Society of Professional Engineers, 2029 K Street, N.W., Washington 6, D. C.

The assets of Nice Ball Bearing Company, division of Channing Corporation, were acquired by SKF Industries, Inc. Nice will continue to operate as an entirely independent organization maintaining present personnel and policies.

The addition of this company to SKF Industries is said to add a new line of bearings featuring performance at lower costs.

NEW PRODUCTS

LUBRICANT FOR ROCKET PROPELLANT SYSTEMS DEVELOPED

Autolene Lubricants Company of Denver, Colorado, has announced the development of a new lubricant for rocket propellant systems. This new product is said to be compatible with liquid oxygen, does not react adversely when used on aluminum and provides protection from wear and galling.

Protex Lox-Film, as the product is called, is a blend of dry powders coated with a special fluoriated binder and a wetting agent, packaged in 6-ounce seamless extruded pressure cans. Sprayed on a surface, Lox-Film is said to form a lubricant that does not set or dry and one that is not affected by extremes in temperature.

The Industrial and Research Division of Autolene Lubricants Company specializes in the development of lubricants to meet the special needs of missiles, space vehicles and ground support equipment, and maintains a technical staff to assist in any space age lubrication problem.

Circle No. 4 on Reader Service Card

NEWLY PERFECTED DIAPHRAGM TYPE PUMP NOW AVAILABLE

For handling lube oils and hydrocarbons, a newly perfected diaphragm type pump for pumping abrasive or corrosive liquids or slurries at moderate pressures is now available from Hydro-Dynamics Research Industries. A key design feature of the new pumps is that the liquid being pumped is isolated and sealed off so as not to come into contact with the mechanical parts of the pump, thus life of the pump is considerably increased due to lessened wear, abrasion, and corrosion. Needle bearings, shafts, and other mechanical parts are positively lubricated and run in a dust-free oil bath.

Potential applications in the agricultural, chemical, food, general industrial and liquid processing industries is expected particularly where abrasive, corrosive chemicals, and slurries are handled.

Circle No. 5 on Reader Service Card

HIGH-TEMPERATURE AND OXIDATION RESISTANT CARBON-GRAPHITE MATERIAL ANNOUNCED

A new grade of GRAPHITAR (carbon-graphite) with high resistance to oxidation and high temperatures has been announced by The United States Graphite Company, Saginaw, Michigan.

GRAPHITAR is a non-metallic material, available in many grades produced from graphite powders and a carbon binder. Parts are compacted under high pressures and sintered at temperatures up to 4500 F. The material can be formed into intricate shapes, ground to tolerances of 0.0005 inch or less, and lapped and polished within a few millionths of an inch. Lighter than magnesium, harder than many steels, self lubricating, and chemically inert, the material is used for seals, bearings, end plates, valves, liners, bushings, and similar parts.

Circle No. 6 on Reader Service Card

NEW HYDRAULIC ACCUMULATORS INTRODUCED

Crescent Hydraulics Co., Allegan, Michigan, has added a new oil-hydraulic accumulator. The accumulator is designed to function as a power storage chamber so a low volume pump can supply a large amount of energy for a brief moment; a pressure compensator to maintain system pressure so holding cylinders do not lose their grip; to eliminate surges and vibration. Double Quad-Ring Seals are said to reduce friction and provide a dependable, long-life barrier to both gases and fluids.

Circle No. 7 on Reader Service Card

CARTRIDGE-TYPE CHECK VALVE OFFERED

A cartridge-type check valve, recently announced by Circle Seal Products Co., Inc., permits simplified installation of the non-leaking 200 Series check valve as an integral part of any pneumatic or hydraulic system.

The C-200 cartridge check valve is designed to be placed in a single bored hole—thereby avoiding bulky complicated piping arrangements with a savings in the design and installation costs.

The compact valve, available in steel or aluminum in sizes from ⅛" to ¾", operates at pressures up to 5000 psi. The Circle Seal cage device restrains the O-Ring, preventing possible washout.

Circle No. 8 on Reader Service Card

SPRAY-ON THREAD LOOSENER OFFERED

A free trial aerosol can of a new lubricant, Mechanic's Thread Loosener (Easy Spray), is available from The Whitmore Manufacturing Company, Cleveland, Ohio. The new product is offered to quickly penetrate rust and corrosion to free tight or rusted pins, linkage, hinges, nuts, bolts, valves and other seized parts.

The formulation is said to be a non-gumming lubricant that eliminates rust and corrosion, increases parts life and minimizes wear, and is recommended for all climatic conditions to combat rust and corrosion even in salt atmospheres.

Circle No. 9 on Reader Service Card

NEW LINE OF WORM GEAR SPEED REDUCERS NOW BEING MANUFACTURED

A new line of worm gear speed reducers offering increased horsepower capacities is manufactured by Cleveland Worm and Gear Div., Eaton Mfg. Co., Cleveland, Ohio. Advantages of the new reducers are said to be due mainly to fan cooling. Plastic or aluminum is employed in the design of the extremely light, specially constructed radial fan which is equally effective in either direction of rotation. Mounting in this position eliminates the extra expense and friction loss involved in the addition of another oil seal.

The new line is available in nine sizes ranging between 3-inch and 12-inch center distances. Ratios extend from 4-1/7:1 to 95:1, ratings from fractional to 175 H.P.

Circle No. 10 on Reader Service Card

(Continued on page 65)

Can you gamble on slim safety margins in low cost jet lubes?

Safety margins in synthetic jet lubes are being minimized by efforts to achieve lowest possible cost. This is not so when formulations are based on the Emolein® Azelates. These proven diesters provide the comfortable safety margins desired by engine manufacturers and commercial airlines.

Because diesters are such a major component in compounded lubricants, the use of azelates reflects directly in improved performance in terms of rubber swell, flash point, volatility, additive response, load carrying capacity and temperature-viscosity behavior.

Be sure that your jet lubes have the margin of safety provided by the Emolein Azelates. It is the *safe* way to save.

Emery INDUSTRIES, INC.

ORGANIC CHEMICALS DIVISION

Export Division, Cincinnati 2, Ohio
Vopcolene Division, Los Angeles
Emery Industries (Canada) Ltd., London, Ontario

Emery Industries, Inc.
Dept. Y-2, Carew Tower, Cincinnati 2, Ohio

☐ Please send Bulletin #409B covering Emolein Azelates.
☐ Please have an Emery Technical Representative call.

Name _____ Title _____

Company _____

Address _____

City _____ State _____

Circle No. 11 on Reader Service Card

TO A CAT'S WHISKER: Palmoshield roll oil is tailored to your mill under such exact laboratory control that fatty acid content will not vary ½%. It is helping many mills to get optimum production, in tonnage and in quality and uniformity of sheet.

Ironsides

SHIELD PRODUCTS

THE IRONSIDES COMPANY, COLUMBUS 16, OHIO • IRONSIDES OF CANADA, LTD., OAKVILLE, ONTARIO

All-domestic American and Canadian roll oils

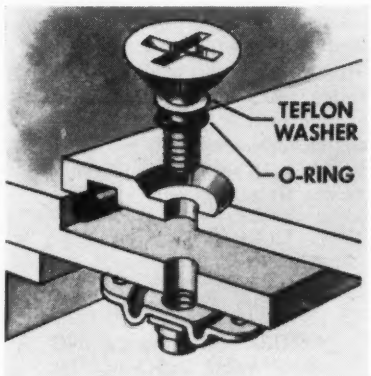
Circle No. 12 on Reader Service Card

NEW PRODUCTS

(Continued from page 62)

NEW FLUSH TYPE STRUCTURAL FASTENER NOW IN PRODUCTION

A new flush type structural fastener with high reusability factor is now in production by Aero Bolt and Screw Company, Inglewood, California. This UNISEAL FASTENER is approved for use on primary aircraft structures.



Its major advantage is its foolproof, self-sealing feature that eliminates the need for additional smear-type sealants. Precision-made, the sealing "O" ring is always under controlled confinement with full metal to metal contact of faying surfaces. This assures a positive, no leakage seal at low or high pressures or vacuum. Many types of "O" rings are available and can be supplied to successfully seal the greatest variety of fluids and gases under the wide variances in temperature ranges.

Special metals, "O" rings, configurations, and drives can be supplied to meet special project requirements.

Circle No. 13 on Reader Service Card

BEARING CLEANING MACHINE DEVELOPED

A bearing cleaning machine, Model MC-4-1, has been developed by the Bearing Inspection, Inc. for cleaning all types of ball and roller bearings from ¼" to 7" O.D. and uses only four sets of easily-changed universal tooling.

It cleans by alternately forcing clean, pressurized solvent and air through the bearing while turning the bearing's inner race. High solvent flow (up to 1½ g.p.m.), along with sharp air blasts, combine with the internal churning to disintegrate and remove old lubricant and dirt particles within 30 seconds, even in shielded bearings with shields in place. The standard model employs a one micron filter to clean the recirculating solvent. Finer filters can be supplied.

Circle No. 14 on Reader Service Card

LUBRICANT AND SEALER COMPOUND DEVELOPED

Armite Anti-Seize No. 609, a new compound designed for automotive and marine industries, consists of suspended metallic lead, and is offered as a thread lubricant and sealer, hose connection and gasket sealant; also tops for press fits, and as cable lubricant. The compound is said to be unaffected by highest or lowest temperatures and assures thread sealing under pressure or vibration. For Hydraulic fluids it has manufacturers' specifications and approval to 100,000 psi. The manufacturer states that the compound is sticky and will not harden, oxidize or corrode.

Circle No. 15 on Reader Service Card

GRAPHITE-LUBRICANT FOR HEAVY INDUSTRIAL EQUIPMENT

MEXACOTE, a quick-drying, nontoxic graphite-lubricant, has been developed by The United States Graphite Company, Division of The Wickes Corporation, Saginaw, Michigan, for use on railroad and heavy industrial equipment. When thinned with turpentine, naphtha, or oleum spirits, the lubricant may be applied by brush, swab, or spatula, leaving a quick drying lubricating action.

Circle No. 16 on Reader Service Card

NEW LOW-COST INDUSTRIAL LUBRICATOR DEVELOPED

Pan-Tech Engineering Company has developed a new low-cost industrial lubricator. The P-T-E Model 606D uses pneumatic pressure to assure uniform delivery rate. The lubricator can be manifolded to deliver lubricant to multiple greasing points, and its independent air supply makes it practical for use in the field or in remote locations.

Circle No. 17 on Reader Service Card

NEUTRALIZING AND OXIDATION ARRESTER FOR MOLYBDENUM DISULFIDE POWDER ANNOUNCED

McGee Chemical Co., Inc., Upper Darby, Pa. has announced a process which is said to increase the effectiveness and dependability of Molybdenum Disulfide powder as a lubricant under conditions of either moisture or high temperature.

The manufacturer reports that commercial grades of small particle size Molybdenum Disulfide powder, when processed by the McGee method, does not show "red hot" at +600F and after exposure of the material at this temperature range, its pH reading remains seven or more.

Circle No. 18 on Reader Service Card

NEW SQUIRT MACHINE OILING DEVICE ANNOUNCED

Usable on a variety of machines, not equipped with a coolant device or oiling arrangement, the new portable Squirt is designed by M-M-A, Inc., Laucaster, Pa., for use as a time and laborsaving device in machine shops.

The double-acting oil pump delivers two squirts of oil at one touch of the button and directs the oil to the cutting edges of drills, taps, etc. Capacity is ⅔ quart.

Circle No. 19 on Reader Service Card

NEW TRANSPARENT PLASTIC DRY FILM RUST PREVENTIVE DEVELOPED

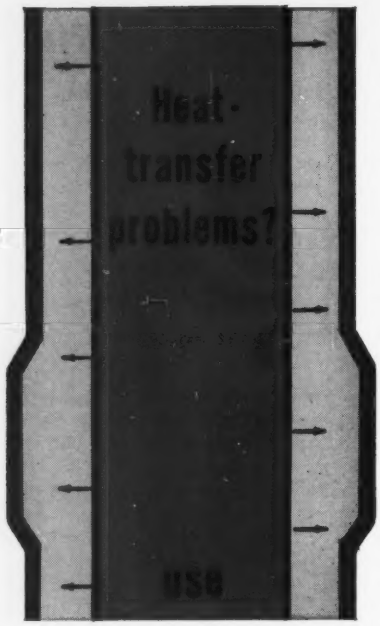
A new, transparent plastic dry film heavy duty rust preventive has been developed by E. F. Houghton and Co., Philadelphia, Pa. Known as Rust Veto 342, the rust preventive coating is especially designed for metal surfaces stored outdoors for long periods where a transparent film is useful so painted or stamped numbers are visible. According to Houghton, Rust Veto 342 is easy to apply and remove. The film will not crack or flow from −40F to 175F. It contains solvent for ease of application, and can be removed with solvent or a mild alkaline cleaner.

Circle No. 20 on Reader Service Card

CARTRIDGE FILLING MACHINE OFFERED

The Geyer CF-60 Cartridge Filler, made by The Filler Machine Co., Inc., Philadelphia 11, Pa., is designed to automatically fill cylindrical cartridges with grease, oil, caulking compound, or other viscous, semi-liquid or semi-solid products at the rate of 20-80 per minute and features automatic piston filling for positive, accurate fill. Time saving features are, automatic cartridge feed, and ease of cleaning and maintenance. The hopper is 16 gauge welded steel, holding 28 gallons. The Geyer fillers are equipped with variable speed drive and explosion proof motors. The two-line model will handle 20-40 containers per minute and the four line model will fill 40-80 cartridges per minute.

Circle No. 21 on Reader Service Card



UCON

BRAND

fluids and lubricants

Ucon heat-transfer fluids do not ordinarily sludge, coke, or gum after months of use at temperatures as high as 450-500°F. Thus, electric immersion heaters and other heat-transfer surfaces stay clean and give long, continuous operation.

Ucon heat-transfer fluids have good viscosity stability and low pour points. These properties permit operation over wide temperature ranges yet eliminate cold weather problems and the need for auxiliary heating equipment.

Ucon fluids and lubricants also give top performance as:

- Rubber and textile lubricants
- Hydraulic fluids
- Cosmetic components
- Anti-foam agents
- Chemical intermediates

Get the facts. Write for the booklets "Ucon Heat Transfer Fluids" and "Ucon Fluids and Lubricants."

Union Carbide Chemicals Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N.Y.

Ucon is a registered trade mark.

UNION CARBIDE CHEMICALS COMPANY

UNION CARBIDE

Circle No. 22 on Reader Service Card

PRODUCT LITERATURE

BEARING BULLETIN PUBLISHED

The new Reali-Slim Bearing Bulletin S-109 is available from The Kaydon Engineering Corp., Muskegon, Michigan.

The new bulletin includes a description of the Type "CP" off-the-shelf Reali-Slim Conrad ball radial bearings available from stock in 90 sizes. Special Kaydon Reali-Slim bearings are also described, providing unlimited design possibilities. These are made in many standard or unusual configurations with from 4" to 40" bore. Types of special Reali-Slim bearings available include angular contact, four-point contact, ball radial, and full complement. These bearings can be ordered with special precision or materials, and for various tandem mountings.

A complete chart of ball bearings in seven series is included in the bulletin. A second chart lists the standard sizes of Kaydon Reali-Slim KT series single row taper roller bearings with up to 30" bore.

Circle No. 23 on Reader Service Card

DESIGN MANUAL FOR ROLLING DIAPHRAGMS

A new 28-page manual covering the selection and application of rolling diaphragm seals for hydraulic and pneumatic actuators, controls, and specialized devices has been announced by the Bellofram Corporation of Burlington, Mass. Covering a complete range for the pre-convoluted and hand-convoluted designs, and in materials ranging from nitrile silicone, Viton A, polyurethane, fluorinated silicone and butyl elastomers, with dacron, teflon and glass fabrics, the design manual contains installation suggestions, application sketches, nomenclature, and design formulas. Supplementary information is included on the effect of shaft torque, piston eccentricity, pressure reversal, hysteresis and other factors.

Special emphasis is placed on applications in pumps, valves, instruments, actuators, regulators, cylinders and pressure transducers, among others, and a loose-leaf Design Parameter Sheet, covering the basic considerations for selection is inserted.

Circle No. 24 on Reader Service Card

NEW BULLETIN DESCRIBES PRESSURE REGULATORS

Bulletin 113, describing Reliance Type A-163 Pressure Regulator, a precision device for laboratory test applications, has been released by American Meter Company. With inlet pressures up to 1 psi, it can be adjusted for outlet pressures ranging from 3.2 to 16 inches w.c.

In addition to specifications and design features, the bulletin includes an illustration of the regulator in section to clearly show its inner construction. Capacities, dimensions, and weight are also given.

Circle No. 25 on Reader Service Card

CENTRALIZED LUBRICATING EQUIPMENT DESCRIBED IN NEW BULLETIN

Farval Centralized Lubricating systems are illustrated in condensed form in the newly released Bulletin No. 27.

The bulletin includes cutaway illustrations, photographs, and charts in presenting the advantages of the Farval systems in providing lubrication protection throughout industry.

Farval Centralized Lubrication systems are engineered to deliver oil or grease under pressure at desired intervals and in exact measured amounts while the machinery operates under full load.

Circle No. 26 on Reader Service Card

BULLETIN ON LIQUID MATERIAL HANDLING RELEASED

Bulletin One which colorfully describes the entire line of liquid material handling equipment manufactured by Blackmer Pump Co., Grand Rapids, Mich., has been released. The new eight-page catalog pictures and describes Blackmer's power driven pumps, variable capacity pumps, proportioning systems, strainers, hand pumps, truck pumps, aluminum transporter pumps, and liquefied gas pumps. It also includes a preliminary selection guide for power pumps. Cutaway photographs of pump models and component part drawings in the literature show the many features of Blackmer pumps.

Circle No. 27 on Reader Service Card

SECTION NEWS

Cleveland—Quenching Oils will be the topic of a Panel Discussion at the March 28 meeting. Panel members and subjects are: Mr. Harry Gilliland, Manufacturing Development Section of the General Motors Technical Center—Subject: Testing and Evaluation of Quenching Oils; Mr. Warren Rushman, Detroit Diesel Engine Division, GMC—Subject: A method for determining the 'H' or Quenching power of a Quenching System; Mr. Tom Frischman, Eaton Axle—Subject: Practical Aspects of Quenching in terms of Selecting the Quench Medium, Day to Day Control, and Problems the Metallurgists Meet in Continuous Production.

Chicago—March 16 has been designated as Past Chairman's Night. Mr. H. William Weaver, Ingersoll-Rand Co., Painted Post., N. Y., is scheduled to talk on the subject, "Keeping the Pressure Up."

Montreal—The topic of the March 1 meeting will be "Railroad Lubrication" presented by Mr. L. E. Hoyer, American Brake Shoe Company.

Hudson-Mohawk—"Worm Gear Lubrication" will be the subject discussed by Mr. L. O. Witzenburg, Cleveland Worm and Gear Div., Eaton Mfg. Co., at the March 22 meeting.

Rochester—The January 12 meeting, cosponsored with ASME, SAE, and RES, featured Mr. William Close, Principal Engineer, Cornell Aeronautical Laboratory, Inc. Mr. Close's subject was, "Racing Cars: History, Development, Design, and Problems." This meeting was designed to be of interest to high school students with engineering interest.

Saginaw—A representative from Standard Oil Co. (Indiana) will discuss "New Developments Ahead in Automotive Lubrication" at the March 30 meeting.

Fort Wayne—Mr. L. J. O'Brian, Chief Engineer, Fort Wayne Division, Dana Corp., was the guest speaker at the February 16 meeting. Mr. O'Brian discussed lubrication of the popular "Powr-Lok" non-slip differential.

Buffalo—In addition to a 10-minute talk on some phase of basic lubrication at the February regular monthly meeting, Mr. H. A. Wilson (Commercial Filters Corp., Lexington, Mass.) will discuss "Filtration as Applied to Petroleum Products."

Plan to attend the ASLE Annual Meeting and Lubrication Exhibit at The Bellevue Stratford Hotel • Philadelphia, Pa.

April 11-12-13, 1961

HOTEL RESERVATIONS

Complete this reservation form and mail to the address shown stating "ASLE Annual Meeting."

The Bellevue Stratford • Broad and Walnut Streets • Philadelphia, Pa.

Please reserve:

Single..... Double..... Twin..... Studio..... Suite ..... Unit.....

at $..... per day, for Arrival.....time.....m

I will check out.....time.....m

DAILY ROOM TARIFF

Single Room and Bath	$ 9.50 to 14.50
Double Bed, Room and Bath	$15.00 to 19.00
Twin beds, Room and Bath	$15.00 to 20.00
Suite (Parlor, twin bedroom and bath)	$30.00 to 55.00

Unit of two twin bedrooms and bath between:
2 persons 18.00 3 persons 21.00 4 persons 25.00

If a room is not available at rate requested, reservation will be made at the next available rate. Reservations must be received not later than 2 weeks prior to the opening date of convention and will be held only until 6 p.m. on day of arrival unless later hour is specified.

Name (please print).....

Address .....

City ..... Zone ..... State .....

PERSONALS

It is well known that many of our ASLE members have far ranging interests, but one who received a feature story in the *Chicago Tribune* deserves special mention. **A. W. (Bud) Lindert** collects old guns. A few years ago he travelled to Nairobi, Kenya to purchase a collection. While there he met a Dr. Thomas who later forwarded him a couple of antique Ethiopian swords, which he had obtained from an Arab trader for 5 pounds. It turned out that these swords had inscriptions on them and an Ethiopian chemist in Lindert's laboratory traced them to the Emperor Haile Selassie. Lindert contacted the court chamberlain and was extended an invitation to visit Addis Ababa, where he was introduced to the emperor. Lindert was a guest of the government for some weeks and was given an opportunity to visit the principal cities and the hinterlands of the country.

A. W. LINDERT

The Lubrizol Corporation announced the appointment of **Mr. L. P. Richardson** to their sales staff. After a training period with the Cleveland Office, he will work as Sales Engineer for the West Coast.

Two changes in The Timken Roller Bearing Company's Engineering Division have been announced. Mr. H. J. Urbach, formerly Company Executive Engineer, has been given the title of Director of Engineering. **Mr. Ralph E. McKelvey,** formerly Assistant Chief Engineer of the Physical Laboratories, has been promoted to Assistant Director of Engineering.

E. S. Karstedt, Jr. has been promoted to the newly created position of director of lubricating oils and wax sales for Continental Oil Company, it was announced.

Battenfeld Grease and Oil Corp., Inc., manufacturer of lubricants and waterproofing products, has announced the election of **Charles E. Gore** as Vice President, Lubricant Sales. Mr. Gore's memberships include: American Society of Lubrication Engineers, National Lubricating Grease Institute, Independent Oil Compounders Association, and American Ordnance Association.

William J. Brown, formerly Staff Product Application Engineer with the Marketing Technical Service Division of Gulf Research & Development Company, has been transferred, effective December 1, 1960, to the marketing element of Orient Gulf Oil Company, Manila, the Philippines, where he will be directly concerned with the administration of sales in the Far East area and with technical services to Orient Gulf Oil Company customers.

Prior to being associated with Gulf Oil, Mr. Brown held Lubrication Engineer positions at Weirton Steel Corporation, Ironsides Company, and American Steel & Wire Division of United States Steel Corporation. He is a member of the Wheeling, West Virginia, Chapter of ASLE.

W. J. BROWN

H. G. RIEGEL

Harold G. Riegel has been promoted to Chicago District Manager of Consumer Sales, Oklahoma-Pate Division of Humble Oil and Refining Company. This new position is said to be created in recognition of the company's expanded sales activities in the industrial and commercial lubricant field within the Chicago area.

Mr. Riegel is a past president of the Milwaukee Chapter of American Society of Lubrication Engineers.

Mr. Milton F. Bates, a past chairman of the Milwaukee Section of ASLE, has succeeded Mr. Riegel as Milwaukee area Industrial Sales Representative for Pate.

VADEN VANISOUL

New Epoch making Additive in the preparation of Water-Soluble Grinding Fluid.

By adding 1% in volume of VADEN VANISOUL to water, a splendid grinding fluid, excellent both in anti-rust and machining capacities, will be produced.

This fluid guarantees the most precise and cleanest finish to the metal work surfaces, while improving the grinding efficiency.

(For further Technical Literature please apply to us)

VADEN

SATO SPECIAL OIL CO., LTD.
30, 3-CHOME, IMAFUKU-NAKA,
JOTO-KU, OSAKA, JAPAN
TEL. OSAKA (33) 2974 • 4090

Circle No. 28 on Reader Service Card

IN MEMORIAM

The many friends of **Mr. James A. Brady** regret to hear of his death with a heart attack on December 13, 1960. Jim, as he was known to everyone, was fifty-one years of age, and a charter member of the Society. He attended the first organizational meeting in Pittsburgh. Later he was Chairman of the Detroit ASLE Annual Meeting and a Past-chairman of the Detroit section. Just recently he was Chairman of a Symposium on Diesel Engines held in Detroit and sponsored jointly by ASLE and the General Motors Corporation. At the time of his death, Jim was Vice-President and Sales Director of the Penn Petroleum Corp.

SOCIETY NEWS

NEW ASLE MEMBERS

DECEMBER, 1960

CHICAGO

Francis J. Reesa
Penola Div. Humble Oil
Chicago, Illinois

Aaron T. Kendrick, Jr.
Danly Mach. Spec., Inc.
Chicago, Illinois

PITTSBURGH

Harry B. Brush
Quaker Chemical Prods. Corp.
Pittsburgh, Pennsylvania

LOS ANGELES

C. A. Goughnour
Union Oil Co. of Calif.
Bakersfield, California

NEW YORK

Glen M. Majors
Ingersoll-Rand Company
Painted Post, New York

PHILADELPHIA

James G. Hinkle
The Franklin Institute Labs.
Philadelphia, Pennsylvania

DETROIT

David S. Thompson
Canfield Oil Company
Detroit, Michigan

Frederick Zajac (R)
Acheson Colloids Corp.
Detroit, Michigan

NORTHERN CALIFORNIA

Charles Jackson
Analysts, Incorporated
Oakland, California

KINGSPORT

W. W. Stark
Sinclair Refining Company
Birmingham, Alabama

Frank O. Walsh, Jr.
Manufacturers Representative
Atlanta, Georgia

Raymond D. Zelek
Esso Standard Div. Humble Oil Co.
Chattanooga, Tennessee

SYRACUSE

Richard F. Stimer (R)
New Process Gear Div. Chey. Corp.
Syracuse, New York

TORONTO

William C. Belfry (R)
Texaco Canada Ltd.
Toronto, Ontario, Canada

Ernest Mills
Shell Oil Co. Canada Ltd.
Toronto, Ontario, Canada

ROCHESTER

Harry W. Patton
Gleason Works
Rochester, New York

OKLAHOMA

Charles W. Martin
Champlin Oil & Refining Co.
Enid, Oklahoma

FOREIGN

Samuel F. Jones
Walkers (Century Oils) Ltd.
Hanley-Stoke-on-Trent, England

UNAFFILIATED

Hyman D. Massin
Texaco, Incorporated
Port Arthur, Texas

William H. Saunders, Jr.
International Lubricant Corp.
Metairie, Louisiana

**Reinstatements*

The picture above was taken at the November meeting of the Cleveland Section. The meeting consisted of conducted tours of the Cleveland Development Division Laboratories of Alcoa, which involved the U N I Directional Load Bearing Machine, testing roll neck bearings, Motor Laboratories and Stress Analysis Laboratory. Mr. David B. Wood of Diesel Engine Division, Cleveland Works, Aluminum Co. of America, presented movies, slides, and a talk dealing with "Field Applications and Lubrication of Aluminum Bearings." Left to right: Mr. Tom Osters (Cleveland Graphite Bronze Div., Clevite Corp.) Chairman, Cleveland ASLE Section; Mr. D. B. Wood, speaker; Mr. George L. Smith, Program Chairman.

A panel of outstanding lubrication engineers were heard on Radio Station WFLN (90.0 AM, 95.7 FM) at 12:05 P.M. to 12:20 P.M. on Saturday, January 7 and January 21.

The program was called "Meet the Engineer". Mr. Thomas J. Bowes, Cities Service Oil Company, served as moderator, and Messrs. David B. Bell, Lincoln Engineering Company; Raymond C. Gunther, Socony Mobil Oil Company; and Kenneth S. Smiley, DuPont; were the panel members. They discussed the role of lubrication in industry and the functions of the Lubrication Engineer. All four men are members of the Philadelphia Section. Left to right: Tom Bowes, Ken Smiley, Ray Gunther, and Dave Bell.

Better Greases Through BAROID RESEARCH

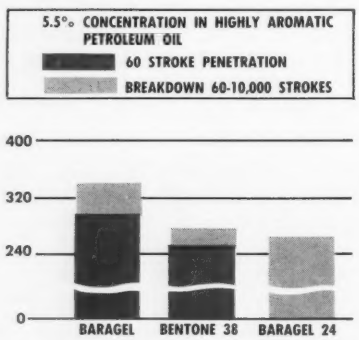
BARAGEL* 24 stabilizes greases made from petroleum oils

LABORATORY REPORT

BARAGEL* 24 in grease made from high aromatic oil

In a particular petroleum oil of high aromatic content (28%), BARAGEL 24 produced a grease completely stable to working in the ASTM grease worker over the range of unworked to 10,000 strokes.

In a series of tests, the oil used had an API gravity of 16.9° at 60° F and a viscosity of 309 SUS at 100° F. The worked penetration was 265 when

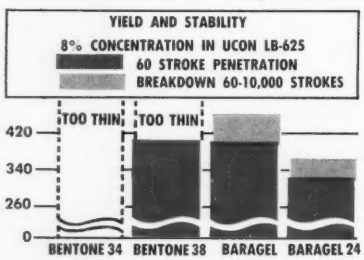


5.5% BARAGEL 24 was used. Comparisons of penetration when using the same percent of BENTONE* 34 and BARAGEL* are shown on the accompanying chart. Write to Baroid Chemicals, Inc. for Data Sheet A-4 which gives full details.

BARAGEL* 24 efficient thickener in greases made with Ucon LB-625

BARAGEL 24 is more efficient in thickening Ucon LB-625 than are BENTONE 34, BENTONE* 38 and BARAGEL. BARAGEL 24 greases are also more stable to working in the ASTM grease worker.

In a series of tests, the gelling agents were stirred into the Ucon LB-625, propylene carbonate was added, heat applied, and the mixture was milled. The chart below compares the results of thickening greases with BENTONE 34, BENTONE 38, BARAGEL and BARAGEL 24. The worked penetration of a grease made from Ucon LB-625 and 8% BARAGEL 24 was 315, with a penetration



of 355 after working 10,000 strokes. Full test details are available in Data Sheet A-1. Write Baroid Chemicals, Inc.

*Trademark of National Lead Company for an organic ammonium montmorillonite.

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Vol. 17, No. 2

Lubrication Engineering

many happy returns

. . . sums up the result of the editorial survey that so many of you helped with last October. More than a third of all of the readers of LUBRICATION ENGINEERING returned the questionnaire. Their recommendations and comments comprise the clearest picture to date of the ASLE, and the most optimistic view of its future.

Extending the reasoning that the best way to know a man is to know what he reads, knowing what the members of the society *want* to read must surely be a sound indication of where the ASLE is going. And, from the nature and range of the material requested, lubrication engineering is on the threshold of a tremendous technological and administrative advance.

But there were other significant indications in the response, far beyond a simple tabulation of the editorial subjects most often requested. For instance, the very magnitude of the response proves the vitality of ASLE as a coherent group.

Scanning the preferences indicated also brought out the fact that the society is quite clearly divided into two main groups whose interests tend to follow somewhat different patterns. One of these groups is looking to the future, seeking new materials, new methods and deeper theoretical insight. The other is chiefly concerned with the present, looking for practical advances in application and procedure.

The first group is seeking to improve and advance lubrication engineering itself; the second is seeking to make industry run better *through* lubrication engineering. Does this not suggest to you that the two groups actually make our society stronger and more effective than it could possibly be if all were on one side or the other? Both lines of emphasis are essential to ASLE's growth and its ultimate contribution to the efficiency of our economy.

We have a very healthy two-group society—long live the difference. And here is a rundown on the editorial subjects most often requested:

1. Standardization
2. Multi-purpose Lubricants
3. High-temperature Lubricants
4. Schedules and Procedure Charts
5. Designing for Proper Lubrication
6. Training Programs
7. Synthetic Lubricants
8. Fire Resistant Fluids
9. Automatic Lubrication Systems

We will try to supply authoritative information on these subjects as it becomes available, and will give it top priority in LUBRICATION ENGINEERING. Many of the same subjects will also be treated in the new Lubrication Engineering Handbook, now in the final stages of preparation. This important milepost in the society's development will be a carefully organized compilation of the work of 73 recognized authorities on various aspects of lubrication and lubrication engineering. You'll be hearing a lot more about it in the months to come.

Your editorial board thanks you again for "Many Happy Returns." It is good that we know each other better.

J. Boyd
Editor

Problems of

LUBRICATION IN SPACE

by M. M. Freundlich,
Consultant, Airborne Instruments Laboratory, Deer Park, L.I., N.Y.

and C. H. Hannan,
Manager of Research, Miniature Precision Bearings, Inc., Keene, N.H.

While the life expectancy of space vehicles is increasing steadily, their complexity is also increasing at a fast rate. A number of the complex functions performed by space vehicles require rotational or linear motion. Due to the high vapor pressure of ordinary lubricating oils, components lubricated with conventional lubricants will operate for only a short time in the high vacuum encountered in outer space.

With the aim of being able to operate eventually small motors in space for a period of over a year, the authors have collected a large number of standard or experimental oils and greases and have tested them in three phases. In the first phase, they eliminated the lubricants with highest evaporation rates in tests in a vacuum of 10^{-7} mmHg. The fifteen best of these were finally tested as lubricants in R-2 size bearings in motors operating at 4000 RPM. in a vacuum of 10^{-5} mmHg. After 1000 hours of operation, an inspection of the disassembled bearings showed that several oils and oil and grease combinations had deteriorated during these tests to only such a slight extent that it can be assumed that they would have operated for a considerably longer time had the tests been continued.

Space vehicles operate in an environment which requires very special design and lubrication considerations. The vehicles are exposed to an ultra-high vacuum of 10^{-8} mm Hg or higher, to photons, to nuclear particles, to micro meteorites, and to other unusual environmental stresses. To fulfil their missions, many of the vehicles carry precision mechanical devices such as synchro motors, servo motors, etc., which require adequate lubrication to function. The most common types of lubricants are oils or greases containing oil. Oil lubricants have a vapor pressure substantially above the ambient pressure in space at the temperature which prevails inside the vehicles. A typical instrument oil could therefore evaporate at such a fast rate that ordinary ball bearings would run dry and seize within a few hours or days unless certain measures are taken.

There are three courses open to the designer to prevent such a failure: (A) he can enclose the moving device in a hermetically sealed box; (B) he can employ bearings that rely on solid lubricants with vapor pressures lower than those of oil lubricants; or (C) he can use standard bearings and employ specially selected oil lubricants with low evaporation rates. In this case he may be able, if necessary, to supply a reservoir of oil for longer life.

Hermetic sealing permits the maintenance of an atmosphere of any desired pressure inside the sealed unit. Under these conditions the lubrication problem will not be more difficult than under ordinary atmospheric conditions. Hermetic sealing is not a very desirable solution. It should be employed only as a last resort, unless it is dictated by other considerations, as for instance, by the need to maintain a man in space. Hermetic sealing requires additional space and weight because the device has to be mounted inside a box that can withstand the pressure difference between the vacuum in space and the pressure inside the box. It requires special electrical feed-throughs and makes preflight maintenance on the ground very cumbersome.

There is available a large selection of solid lubricants and many new ones are continuously developed, especially for extreme high-temperature operations. Low torque ball or roller bearings with solid lubricants require specially designed or specially treated nonstandard bearings. Most of the solid lubricants have, even under ordinary atmospheric conditions, to the

Presented at the 15th ASLE Annual Meeting, Cincinnati, Ohio, April 1960.

authors' knowledge, a life expectance of only a few hundred hours.* The authors are also conducting at present a thorough investigation into the properties of solid lubricants.

The purpose of this paper is to describe some results of an investigation into the life expectancy of instrument components with bearings lubricated with selected oils and greases under high vacuum conditions.

Oil lubricants do have one advantage over solid lubricants in that their life can be extended appreciably by replacing the evaporated oil from a reservoir. In this case a lubricant has to be selected that does not leave a solid residue.

To determine the life expectancy of standard bearing with oil or grease lubrication, approximately 65 samples of oils and greases have been collected. The sample selections were made after more than 25 lubricant manufacturers were contacted and their recommendations requested. Some lubricants were selected because they were known to have a low vapor pressure, some were well-known high vacuum pump oils, while others were recommended for various other reasons.

The testing proceeded in 3 phases. In the first phase, the samples with extremely high evaporation rates were eliminated in a low vacuum test. In the second phase, the best samples were exposed to high vacuum, and their evaporation rate determined. In the third phase, those samples with the lowest evaporation rates were tested as lubricants in instrument type bearings installed in fractional horsepower motors operating in high vacuum.

In phase 1 (1) the samples were filled into small glass cups of approximately $\frac{5}{8}$ inch diameter and 1 inch length. The cups were placed into an aluminum block inside a vacuum bell jar as shown in Fig. 1. The temperature of the oil was maintained at 85C while the vacuum in the bell jar was maintained at approximately 10^{-2}mm Hg. The weight of the sample was measured before it was placed into the bell jar and at various intervals afterwards. It was experimentally established that the evaporation rate was highest at the beginning, and that after not more than 2 days, a steady-state rate was established.

The samples with the lowest steady-state evaporation rate were investigated in phase 2. Six samples at a time were placed into the aluminum block and put into a high-vacuum chamber. The temperature of the oil samples was raised to 110C. A copper cylinder cooled with liquid nitrogen (shown in Fig. 2) was suspended above the aluminum block. The cylinder was subdivided into six sections, so that each oil sample was placed under one section. Due to the cryogenic pumping of the liquid nitrogen trap, operating in conjunction with a 3-inch oil diffusion pump, it was possible to maintain a vacuum of 2×10^{-7}/mm Hg inside the chamber. The initial and the steady-state evaporation rates were established by weighing the sample before the test, after two days, and after two to three additional days. These

Fig. 1. Low-Vacuum TEST SETUP Showing Heating Block with Six Samples.

Fig. 2. Liquid Nitrogen Trap. Showing Compartments Separating Lubricant Samples.

*Note: Bearings with silver coated balls are reported to have been life-tested for over 2000 hours in vacuum; they are difficult to make and will not be able to operate under ordinary atmospheric conditions without the addition of a protection for the silver coating.

tests yielded 15 oils and greases which showed a steady-state evaporation rate of 4 x 10^{-4} gr/cm^2/hr or less. (1 x 10^{-4} gram/cm^2/hr is equivalent to an evaporation of approximately 1mm thickness in 1000 hours.) The selected lubricants and their properties are listed in Table 1.

The best oils and greases were subjected to an operational test in phase 3. Sixteen small 400 c.p.s. hysteresis motors were operated inside the vacuum chamber. The two bearings of each of these motors were lubricated with one of the selected oils or greases. Among the selected lubricants was one oil that had a particularly high initial evaporation rate while the steady-state evaporation rate was well within the set limits. This oil was tested both in the as-supplied state and in a carefully outgassed condition. The bearings, type R-2, were made of 440C stainless steel with paper-based phenolic retainer rings, type PPG (MIL-P-3115) and with two shields mounted in the outer rings.

The bearings were impregnated before the shields were mounted. The impregnation was done in the low vacuum chamber at a pressure of 10^{-2}mm Hg. Both the oil and the bearings were baked separately at a temperature of 100C for one hour. The bearings were then dropped into the oil container. After 10 minutes the vacuum was broken. The bearings stayed immersed in the oil at atmospheric pressure for at least one hour. They were then centrifuged for one minute at a force of 200 g. An average of between 15 and 20 milligrams of oil was absorbed inside the retainer ring. In the case of greases, the bearings were first impregnated with a compatible oil, thus preventing the retainer ring from drying out the grease. Approximately 15 milligrams of grease were added by placing it carefully at the ball-race contact after completion of the oil impregnation.

Vibration, torque, and internal clearance were measured on all bearings. Apparent power consumption, speed, and assembled motor clearances were measured for each motor. Four motors were mounted on each of four aluminum bases (Fig. 3). The motors were loaded with electrodynamic brakes consisting of aluminum disks mounted on the motor shafts and running between the pole pieces of electromagnets. The current of each magnet was adjusted until the motor was slowed to 4000 RPM from an unloaded speed of approximately 6500 RPM. The mounting bases for the motors were kept at a constant temperature of 75C during the life tests. This is the upper temperature limit at which the heat sink of the space-borne electronic equipment is expected to operate.

The vacuum system was the same as that used in phase 2 of the investigation. A somewhat modified liquid nitrogen trap was used. The system, loaded down

TABLE 1.—Steady-state Evaporation Rate of Oils and Greases Selected in Phase 2

OILS

SERIAL NO.	OIL TYPE	VISCOSITY AT 100 F	VISCOSITY AT 210 F	EVAPORATION RATE AT 110 C AND 10^{-7} MM HG
		CTST	CTST	10^{-4} GR/CM^2/HR
1	Silicone	40	16	0.5
2	Complex Ester	84	12	0.5
3	Complex Ester	52	10	0.5
4	Mineral	380	27	0.7
5	Diester	38	6.7	0.8
6	Mineral	235	22	1.0
7	Silicone	31	12	1.5
8	Silicone	45	14	3
9	Organo-Silicone Co-polymer	75	16	4

GREASES

SERIAL NO.	GREASE COMPOSITION: OIL	GREASE COMPOSITION: THICKENER	DROP POINT	EVAPORATION RATE AT 110 C AND 10^{-7} MM HG
			°F	10^{-4} GR/CM^2/HR
11	Ester	—	—	0.1
22	Silicone	Lithium Soap	520	1.0
33	Silicone	Indanthrene Vat Dye	550	1.0
44	Silicone	Lithium Soap	400	1.5
55	Mineral	Clay + 3% MoS_2	—	2.0
66	Ester	Non-melting thickener	500	2.0

TABLE 2.—Results of Life Tests of Oils and Oil-Grease Combinations

GROUP	SEQUENCE	OIL	NO. IN TABLE 1	GREASE	NO. IN TABLE 1	OPERATING TIME–HOURS	CAUSE OF FAILURE
I	a. (best)	Mineral	6	—		1000	—
	b.	Mineral	4	—		1000	—
	c.	Silicone	1	Silicone	22	900	Electrical
	d.	Silicone	1	Silicone	33	1000	—
	e.	Silicone	1	—		1000	—
II	f.	Complex Ester	2	Ester	11	1000	—
	g.	Diester	5	—		1000	—
	h.	Complex Ester	2	—		1000	—
	i.	Complex Ester	3	—		1000	—
	j.	Complex Ester (outgassed)	3	—		1000	—
	k.	Silicone	8	—		910	Electrical
	l.	Organo-Silicone Co-polymer	9	—		670	Electrical
	m.	Mineral	4	Mineral	55	400	Mechanical
III	n.	Silicone	7	—		400	Lubricant
	o.	Complex Ester	2	Ester	66	230	Lubricant
	p.	Silicone	7	Silicone	44	220	Lubricant

with the equipment inside the vacuum chamber, maintained a vacuum of approximately 2 x 10^{-5} mm Hg.** The tests were run continuously during the working week. The vacuum was broken for the week-ends and the motors inspected. The tests were run for 1000 hours of operation.

Nine motors operated for the full length of time. Two motors operated for approximately 900 hours only, due to electrical difficulties. One motor ran for 670 hours for the same reason. One motor failed for mechanical reasons. Three motors failed because of lubrication failures due to dried-out bearings. Table 2 lists the test results and the causes of failure of the motors.

At the end of the life tests, motor performance and clearance were measured again. Each motor was carefully disassembled and the bearings were inspected under a microscope. This inspection permitted the classification of the lubricant samples into three well-defined groups. The bearings within Group I, of which Fig. 4 shows a typical example, still contained a large amount of lubrication and showed no wear on the balls, the races or on the retainer rings. The lubrication appeared adequate for a much longer bearing life, possibly for another 500 to 1000 hours. In Group II (see Fig. 5) the bearings were still operative; however, the condition of the lubricant gave promise of only a slight amount of additional life. The race and ball surfaces showed a slight scuffing, which is generally indicative of marginal lubrication. Bearings in Group III (see Fig. 6) were in motors which had early failures due to lubrication breakdown. The bearings show complete absence of any oil on the metal surfaces or in the re-

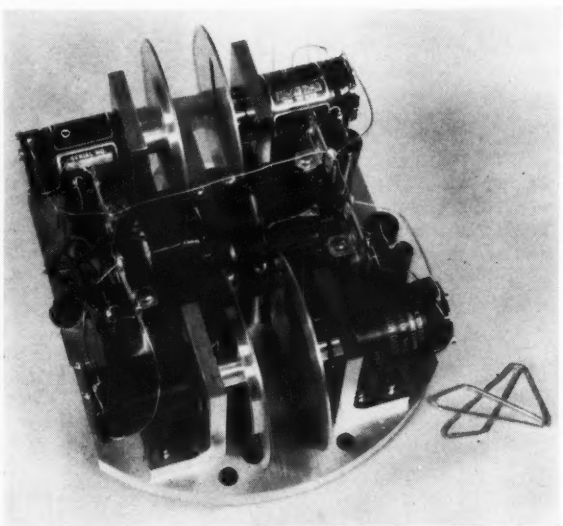

Fig. 3. LIFE-TEST SETUP. Showing One of Four Basic Plates with Four Motors, Aluminum Disks, and Electromagnets for Loading of Motors.

**Note: This vacuum is somewhat lower than that desired for the life tests. Initial results are none the less believed to be essentially correct because the published vapor pressures of various oils at a temperature of 100C are 1 to 2 orders of magnitude above the test pressure. This takes into consideration that the bearings will run approximately 25C hotter than the motor mounting. In addition, in comparing the evaporation rates obtained in Phase 1 of the investigation at a temperature of 85C and at a pressure of 2 x 10^{-2} mmHg with those of phase 2 at 110C and 2 x 10^{-7} mmHg, it was found that for the oils used in phase 3 the evaporation rates differ by less than one order of magnitude, in most cases the difference is even smaller.

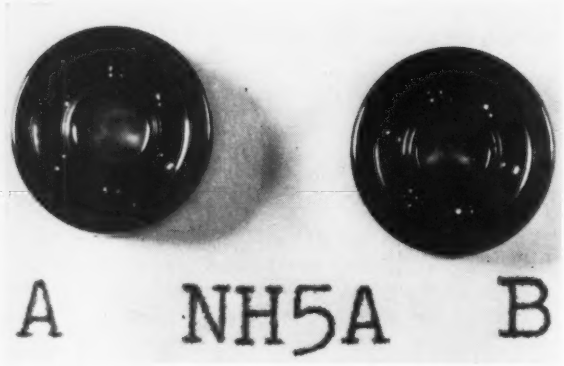

Fig. 4. Typical Set of Bearings in Group I After 1000 Hours of Life Test.

Fig. 5. Typical Set of Bearings in Group II After 1000 Hours of Life Test.

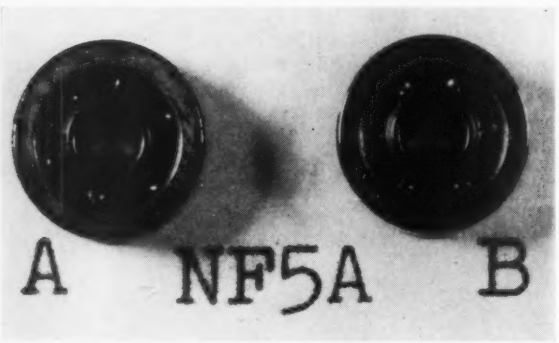

Fig. 6. Typical Set of Bearings in Group III After Failure.

tainer rings. They show a formation of substantial quantities of hard abrasive material. The retainers are badly discolored, worn, and somewhat charred due to excessive heat.

Of the 15 lubricants life-tested, five oils and oil- and grease-combinations fall into Group I. This group consists of two high-temperature mineral oils, one silicone oil and two silicone oil and grease combinations. Group II is composed of seven oils and oil- and grease-combinations. Most of these are esters, one is a silicone oil, one a silicone-organic co-polymer, and one a mineral oil combined with a moly-disulphide grease. The oil sample j which was especially outgassed before impregnation did not behave differently than the untreated sample i. Group III contains one silicone oil, one ester oil and grease combination, and one silicone oil and grease combination.

CONCLUSIONS

In a test involving 40 oils and 25 greases, 15 lubricants were selected, which showed the lowest evaporation rates. These were tested in small fractional horsepower motors operating at 4000 RPM. Most of the motors operated for the full 1000-hour life test. Only three showed early lubricant failure due to dried-out bearings. Several bearings showed no measurable wear and no apparent lubricant deterioration, indicating that they had not approached the limit of their useful life. Among the best lubricants some high-temperature petroleum oils performed better than esters that had lower evaporation rates. Among the silicone oils and greases, one oil and two oil- and grease-combinations were found to be excellent, while others were moderately good or bad.

The long range objective of the study is to extend the life of instrument bearings operating under space conditions to a year or more.

ACKNOWLEDGMENT

The authors acknowledge with thanks the close cooperation of P. MacLean of AIL, A. D. Robertson, formerly of AIL, at present with the U.S. Air Force, and R. Barba of AIL in the construction of the experimental equipment and the measurements.

The work reported herein was supported in part by a Department of Defense contract.

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1. Freundlich, M. M., and Robertson, A. D., "Lubrication Problems in Space Vehicles," Advances in Astronautical Sciences, Vol. 4, Proceedings of the 5th Annual Meeting of the American Astronautical Society, December 1958, Washington, D.C., Noble Offset Printers, Inc., New York, N.Y., p. 142-153.

Editor's Note: Authors are furnished a copy of each discussion and invited to submit a closure. Since no closure was submitted for the above article, it may be assumed that the author(s) either concurred with the discussor(s) or did not feel that a reply was necessary.

DISCUSSION

by A. Beerbower,

Esso Research and Engineering Co., Linden, New Jersey

The initial reaction of a petroleum engineer to the question of lubrication under space conditions is that fluid lubricants are all inadequate for these temperatures and pressures. It has been very gratifying to find that Dr. Freundlich has disproved this pessimistic prediction.

The basis for the anticipated loss of lubricant is the conventional extrapolation charts (1) used for many years to predict the boiling points of hydrocarbons at low pressures. These charts have a good experimental background down to 10^{-2} mm, and are supported by limited data down to 10^{-6} mm, for compounds boiling below 800F. at 760 mm. However, outside this region data are sparse or non-existent, and the charts consist largely of extrapolations on a mathematical basis.

As a means of illustrating the extent of our inability at present to predict relative evaporation rates at extremely low pressures, all of Dr. Freundlich's data was reduced to a common basis. The normal mid-boiling points of the nine fluid products included in his dynamic test were estimated from the viscosities by various unpublished correlations, and reduced to boiling points at 2×10^{-5} mm by the Maxwell-Bonnell charts. No attempt was made to predict the behavior of the greases because of their complex nature. The author's static test conditions of 110C. and 10^{-7} mm were also brought to the dynamic test vacuum by the same charts.

Fig. A1 illustrates the lack of correlation between the predicted boiling points and the static test data. All fluids except one (#2) should have boiled off as rapidly as heat could be supplied to the samples, whereas they actually showed only a very low rate which was not even inversely proportional to the boiling point. The dynamic test results, where the conditions were less severe in pressure and temperature, also were not predicted at all well by the available correlation methods. However, the three oils which proved to be best were among the four predicted to have long lives, so that the prediction is not as bad as in the static case. It follows naturally that the correlation of the static and dynamic tests is not very good.

It appears that Dr. Freundlich's work reopens the question of the prediction of vaporization of oils at extreme conditions, and justifies a considerable amount of further experimental work.

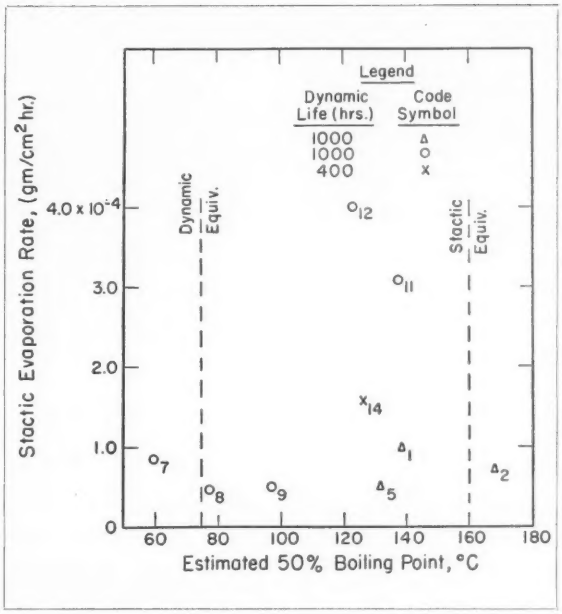

Fig. A1. Fluid Boiling Points (@ 2×10^{-5} mmHg) vs. Static and Dynamic Test Results.

(1) Maxwell, J. B., and Bonnell, L. S., Ind. & Eng. Chem., *49*, p. 1187 (1957)

An operational test of a fire resistant fluid, phosphate ester type, was conducted in a circulating oil system for lubrication of journal type bearings in an axial flow compressor. The lubricating quality of the fluid was judged satisfactory. A method was devised for replacing a petroleum oil in the system with the fluid without an equipment shutdown.

Evaluation of a FIRE RESISTANT FLUID *in a Circulating Oil System*

by E. J. Tullos,
Union Carbide Nuclear Company
Paducah, Kentucky

INTRODUCTION

Fire resistant fluids were developed primarily to promote safety in hydraulic applications involving high oil pressures and an unavoidable source of ignition. Their usage has, however, been extended to a number of other industrial applications were fire protection safety is of paramount consideration.

Normally, circulating oil systems using petroleum base oils for the lubricant do not present fire hazards which cannot be suitably controlled by standard fire protection systems. However, some systems, particularly in the chemical industry, are not conducive to the use of water for fire protection, and the use of dry type chemicals or CO_2 systems would involve prohibitive expense for extensive area coverage. Fire hazards can easily exist in circulating oil systems from broken oil lines, leaking connections, and from reaction of the oil with process gases leaking through seals. Where such conditions are critical, the fire resistant type fluids merit consideration.

The Paducah, Kentucky, plant of the Atomic Energy Commission, operated by the author's company, utilizes a large number of axial flow compressors for gas pumpage in the gaseous diffusion process to separate uranium-235 and uranium-238 isotopes in uranium hexafluoride gas. The compressors are housed in four buildings, each building being divided into a number of units. Each unit has its individual circulating oil system requiring approximately 10,000 gallons of oil, which is used to lubricate the bearings of the compressors and their electric motor drives. Continuous operation of the compressors is required and extensive equipment shutdowns are costly and are to be avoided.

Following a serious fire, a study of the potential fire hazards which existed in the oil systems was initiated which resulted in an investigation to determine the most suitable method of providing fire protection. One phase of this investigation was concerned with the evaluation of a phosphate ester base fire resistant fluid to replace the petroleum base oil as the lubricant, and the determination of a suitable method of replacing the oil with the fluid without an equipment shutdown to drain and flush the oil from the system.

Presented at the 15th ASLE Annual Meeting, Cincinnati, Ohio, April 1960

PRELIMINARY LABORATORY TESTS

Preliminary laboratory tests were conducted to compare the properties of the phosphate ester fluid with the petroleum oil in use, and to evaluate a proposed method of directly adding the fluid to the oil system, then removing the oil by centrifugation.

The typical properties of the phosphate ester fluid and the petroleum oil, as determined by standard ASTM methods, are shown for comparison in Table 1.

TABLE 1.—Typical Properties of Phosphate Ester Fluid and Paraffinic Base Oil

	PETROLEUM OIL	PHOSPHATE ESTER FLUID
Specific Gravity, ASTM D 287	0.898	1.15
Viscosity SUS ASTM D 88		
@ 100 F,	300	220
@ 210 F	51	42
Flash Point, °F, ASTM D 92	425	455
Fire Point, °F, ASTM D 92	485	685
Autogeneous Ignition Temp., °F, ASTM D 286	~600	>1200
Neutralization No. (Total Acid), Max, ASTM D 664	0.05	0.10
Rust and Oxidation Inhibitors	Yes	No

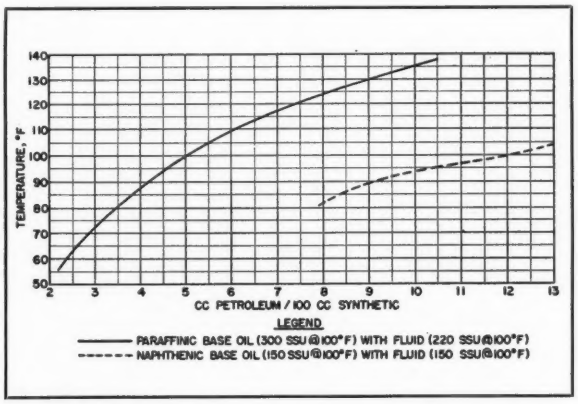

Fig. 1, Solubility of Petroleum Oils With Phosphate Ester Base Fluids

Centrifugal separation of mixtures of the synthetic fluid and oil were evaluated in the laboratory by determining the solubility of the oil in the fluid, thereby establishing the degree of separation that could be obtained. Since miscibility was strongly a function of temperature, these solubility tests consisted of heating mixtures of oil and fluid to establish complete miscibility, slowly cooling the solution and noting the temperature at which two phases appeared, as evidenced by turbidity in the solution.

The temperatures were reproducible to within 3 to 4F and, as presented in Fig. 1, the data showed that a mixture containing 3.8% of the paraffinic oil would exist at 85F and that all of the oil would not separate even at lower temperatures. Vendors information indicated that a mixture containing less than 5 or 6% petroleum oil in the phosphate ester fluid would not have significantly different fire resistant properties than the pure fluid. Confirming tests by our laboratory showed that the addition of up to 15% petroleum oil reduced the autogeneous ignition temperature of the fluid only slightly. Therefore, it was considered that a satisfactory mechanical separation at temperatures of 80-90F could be obtained, and that a cooling system for reducing mixture temperatures prior to centrifuging would not be necessary since bulk oil temperatures do not exceed 90F.

Solubility tests were also made using a naphthenic base, uninhibited oil mixed with the synthetic fluid. A much higher degree of solubility was found as shown in Fig. 1. At 85F, the naphthenic oil showed a solubility of 8.3% with the fluid. Due to this degree of solubility, no further tests were made to determine if the comparative difference with paraffinic oil was due to the naphthenic base, the inhibitors in the paraffinic base oil, or the combination of the inhibitors and the difference in oil bases.

Centrifuge separation tests were also performed to verify the solubility data and to insure that no unsuspected emulsion problems would be encountered in actually separating the oil and fluid. The conditions and results of these tests are presented in Table 2 with the 'Expected' results taken from the phase diagrams shown in Figs. 2 and 3 which were derived from the solubility test data. The expected results were estimated by reading the respective solubilities on both legs of the solubility curve at the temperature of the heavy stream which was taken as the temperature of the oil in the centrifuge. Considering our experience and experimental errors, it is believed that such phase

TABLE 2.—Centrifuge Tests

	FEED		HEAVY STREAM				LIGHT STREAM	
					% PETROLEUM OIL		% PETROLEUM OIL	
MIXTURE	TEMP., °F	FLOW, GPM	TEMP., °F	FLOW, GPM	FOUND	EXPECTED	FOUND	EXPECTED
1[a]	88	3.2	96	2.6	5	4	88	87
2[b]	86	3.1	98	2.4	10	11	74	68

[a]Mixture 1, 24% Paraffinic Base Oil—76% Synthetic Fluid.
[b]Mixture 2, 45% Naphthenic Base Oil—55% Synthetic Fluid.

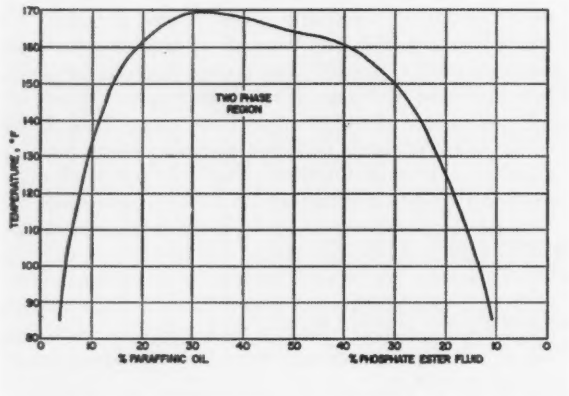

Fig. 2, Phase Diagram of Paraffin Base Oil and Phosphate Ester Base Fluid

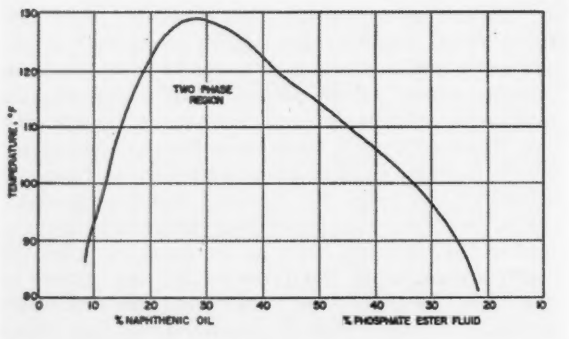

Fig. 3, Phase Diagram of Napthenic Base Oil and Phosphate Ester Base Fluid

diagrams can be used to predict the actual performance for large scale operation. The phase diagram also shows that 13% of the fluid at 96F would be dissolved in the paraffinic base oil, and 32% of the fluid would be dissolved in the naphthenic base oil. The amount of fluid dissolved in the oil might be recovered by distillation, but no further investigation was made in this test.

The laboratory tests were considered suitably indicative of results to be expected from adding the fluid to an operating system; however, due to the critical operation of the compressors and the volume of oil involved, confirmation of the laboratory tests was desired under actual process conditions and full size equipment. Since a test system with a prototype compressor was available, an operational test of the fluid as a lubricant, and the addition of the synthetic fluid to the oil system was feasible. Extensive testing was undertaken using this prototype equipment and the details of the test and the results obtained are outlined below.

TEST EQUIPMENT AND PROCEDURE

The portion of the prototype loop used for the lubricant test consisted of a single operational size axial flow compressor direct driven at 1180 rpm by an electric motor. The two compressor load bearings were steel backed, babbit lined, journal types, 5.5 inches ID by 6.5 inches long. The thrust bearing was a Kingsbury unit with babbit lined shoes. Running bearing loads were approximately 180 psi on both journals; however, the thrust bearing load was essentially zero due to the extremely low load operation, characteristic of this prototype installation. The compressors were operated intermittently during the test, approximately 8 hours on and 8 hours off, and the loop operations required that the compressor startup to full speed or a shutdown to zero rpm be made in less than a minute, which imposed a more stringent loading on the bearings than the running load indicates. Lubrication of the electric motor bearings with petroleum oil through constant level oilers was necessary due to a deleterious effect of any fluid leakage on the insulation used for the motor windings. Standard packing material for petroleum oil was used in the pumps and valves and no changes were made in the procedure for normal operation of the loop.

New load bearings were installed in the motor end and thrust end of the compressor. The oil system was filled with 50 gallons of petroleum oil and the bearings were 'run in' during 100 hours of intermittent service. With the system in normal operation, the oil tank was drained to a minimum level (27 gallons) and 23 gallons of fluid was added as make-up. The oil was then removed by bypassing some of the mixture of oil and fluid to a De Laval type centrifuge. The heavier fraction was circulated directly back to the tank as shown in the line diagram, Fig. 4, and the 'light' fraction was withdrawn from the system. The inlet temperature to the centrifuge was held at 85F and 28.12 gallons of fluid was added to the tank as make-up. The centrifuging cycle was continued until no further light material could be removed. Analyses of the two tanks showed that 4.5% by volume of the petroleum oil remained in the fluid in the circulating system, while

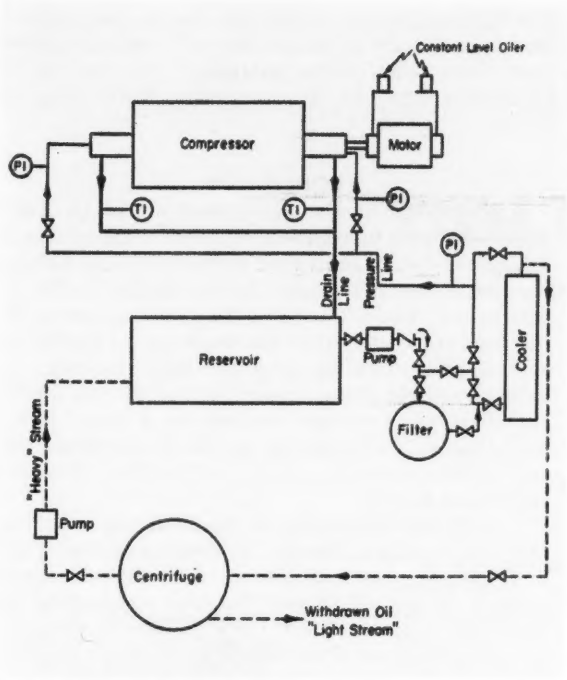

Fig. 4, Circulating System Piping

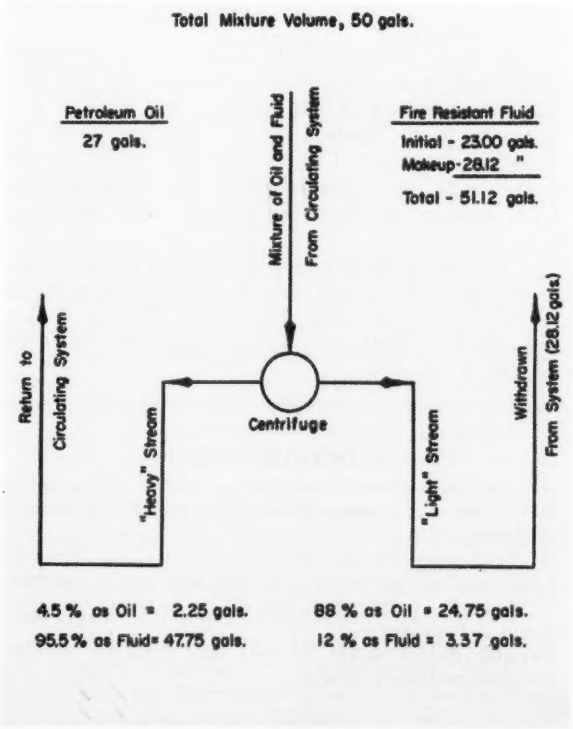
Total Mixture Volume, 50 gals.
Petroleum Oil
27 gals.
Mixture of Oil and Fluid From Circulating System
Fire Resistant Fluid
Initial - 23.00 gals.
Makeup - 28.12 "
Total - 51.12 gals.
Return to Circulating System
"Heavy" Stream
Centrifuge
"Light" Stream
Withdrawn From System (28.12 gals.)
4.5 % as Oil = 2.25 gals.
95.5 % as Fluid = 47.75 gals.
88 % as Oil = 24.75 gals.
12 % as Fluid = 3.37 gals.

Fig. 5, Centrifuge Operation Results

the lighter fraction of oil withdrawn from the system was found to contain 12% by volume of the phosphate ester fluid. The liquid flows through the centrifuge with the volumes involved are illustrated in the schematic material balance diagram, Fig. 5. After 50 hours of further operation of the loop, with the centrifuge disconnected, analysis of the fluid system showed the petroleum oil content had increased slightly.

This increase evidently resulted from the inherent cleaning action of the fluid which removed all residual petroleum products from the lines, filters, and tank. Phosphate ester fluid added to the system as make-up during the remainder of the test gradually reduced the oil content below the minimum obtained by centrifuging.

The test was continued for a period of 6½ months, during which time the total accumulated operating time amounted to 877 hours of intermittent service, as required by the loop operation. Oil temperatures and pressures as shown in Table 3 were recorded during each period of operation and no significant changes were noted.

TABLE 3.—Typical Operating Conditions—Circulating System

	LUBRICANT	
	PRESSURE, PSI	TEMP., °F
Inlet Header	7.25	100
Compressor Bearings		
Motor End (Inlet Side)	5.50	—
Thrust End (Inlet Side)	5.50	—
Motor End (Outlet Side)	—	128
Thrust End (Outlet Side)	—	120

The test was concluded when a failure occurred on the compressor external to the oil system. The bearings were slightly damaged which made evaluation of the test more difficult. Damage was not extensive enough to destroy the bearings, however, and the conclusions reached following examination, were felt to be significant. A physical comparison of the synthetic fluid lubricated journal bearings was made with a bearing obtained from a process system compressor which had failed for the same reason and had been lubricated with only petroleum oil. This compressor had been in continuous duty service for 23 months. Pictures of a new bearing insert, the synthetic fluid lubricated bearing inserts, and the petroleum oil lubricated insert are shown in Fig. 6. The axial scratches on the used inserts resulted from removal jigs and the circumferential marks were attributed to the excessive bearing loads which resulted from the failure on the compressor. With the exception of these scratches, all used bearings were considered in good condition, properly lubricated and showed only normal wear.

Analyses of the fluid at the end of the test showed no increase in the acid value or any noticeable change in the viscosity of the material. A slight darker color was noted, as governed by the color of the dissolved oil in the fluid and a general inspection of the system disclosed no evident products of oxidation or corrosion.

A complete inspection of the system pumps and valves was not considered necessary since no increase in leakage from the pump seal was observed during the test. In a permanent system, the pump seals would probably require replacement with phosphate ester resistant type material.

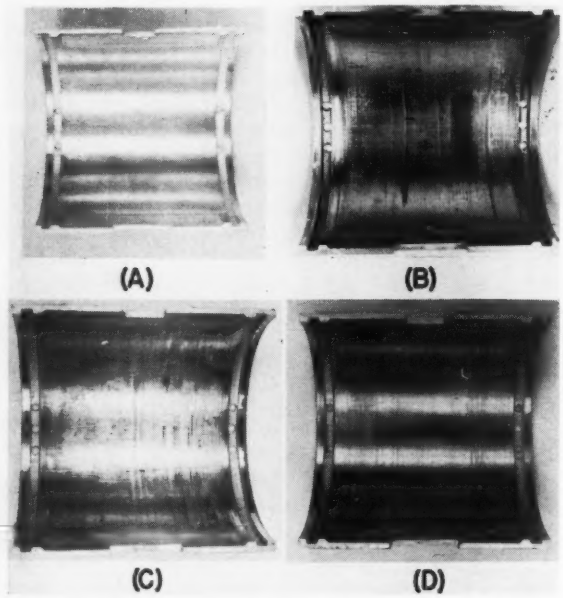

Fig. 6, Load Bearing Inserts From Fire Resistant Fluid Test

(A) New Insert

(B) Insert From Process Compressor (Oil Lubricated)

(C) Insert From Test Compressor Thrust End (Synthetic Fluid Lubricated)

(D) Insert From Test Compressor Motor End. (Synthetic Fluid Lubricated)

SUMMARY

An operational investigation of a phosphate ester base fire resistant type fluid was conducted to evaluate (a) the fluid properties for lubrication of journal type bearings by means of a circulating oil system and (b) the replacement of a petroleum base oil in an operating system by direct addition of the fire resistant fluid without an equipment shutdown to drain and clean the oil system. Preliminary laboratory tests were made to determine the solubility of the oil in the fluid so that the feasibility of centrifugal separation of a mixture of the two materials could be established.

The operational test was conducted by directly adding the phosphate ester fluid to the petroleum oil in a circulating oil system used to lubricate the bearings of an axial flow gas compressor, and then separating the two lubricants by centrifuging. The centrifugation reduced the petroleum oil content in the circulating system to less than 5% while 12% of the phosphate ester fluid added was dissolved in the petroleum oil and withdrawn from the system. The lubricating quality of the phosphate ester fluid was evaluated by noting the constancy of the circulating system temperatures and pressures and by comparison of the bearing inserts with those from similar equipment, operated in the processing plant and lubricated with the petrolum oil.

CONCLUSION

The results of the operational test of the phosphate ester base fluid showed the lubricating quality of the material to be equivalent to the petroleum oil used for comparison and suitable for installation in the circulating oil system. Normally, the loads imposed on the bearings and the length of the test would be insufficient for the proper evaluation of the fluid; however, the intermittent compressor operation and the startup and shutdown requirements resulted in a more severe operating condition than is usually encountered. This type of service would be equivalent to years of normal continuous duty.

Onstream introduction of the phosphate ester fluid into the circulating system by direct addition of the fluid into the petroleum oil reservoir with subsequent removal of the oil by centrifugation successfully reduced the oil content below the 5% allowable for a fire resistant lubricant. This method would merit consideration for any system where equipment shutdown is critical or where maintenance costs to drain and clean the system would be prohibitive. Distillation of the petroleum oil withdrawn from the system to recover the entrained phosphate ester fluid was not investigated, but would probably be feasible if an economic evaluation of the removal method showed the fluid recovery to be necessary. Simple laboratory tests to determine the solubility characteristics of a phosphate ester fluid and any petroleum oil involved are required before considering separation of the two materials by centrifugation.

The direct addition and usage of the phosphate ester fluid in the circulating oil system did not have any adverse effect on the standard materials of construction in the system designed for petroleum oil. Extended operation of the system with the fluid would probably require replacement of the pump packing with material recommended for use with phosphate ester fluid.

Limited analytical data on the fluid at the conclusion of the test did not indicate any adverse effect on its lubricating qualities. Based on results of similar industrial applications, further analyses were not deemed warranted.

ACKNOWLEDGEMENT

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W. R. Rossmassler and other personnel of the Paducah Laboratory for performance of tests and analysis of data.

R. W. Levin, S. Bernstein, and R. F. Battistella for comments and suggestions.

Various vendors of fire resistant type fluids for samples and data on their products.

Modified Ethylene Polymers as

COLD-ROLLING LUBRICANTS

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It was observed previously that, by retention at elevated temperatures and pressures, ethylene yields lubricant base oils (3). Hydro-carbon oils derived from olefin-polymerization as well as from natural petroleum were catalytically processed with fats in an attempt to produce improved cold-rolling lubricants. E P characterization and evaluation in a laboratory mill indicates that these synthetic oils compare very well with more costly proprietary lubricants.

INTRODUCTION

Investigation on catalytic polymerization of ethylene has been quite extensive, whereas studies on non-catalytic reactions of ethylene at elevated pressures have attracted less interest. Ipatieff (1) was the first to demonstrate that ethylene gas polymerizes under pressure at 325 C without the employment of any catalyst. Seger, Doherty, and Sachanan (2) showed for the first time that when ethylene is under a pressure of 3800 psi at 321 C, 40 per cent of the compound is polymerized in 10 hours into a heavy oil comparable to SAE 10-20 mineral oil. Bhattacharyya and Shamaiengar (3) extended the study of the reaction at higher pressures and temperatures and attempted to establish suitable parameters of experimental conditions for obtaining heavy polymer oils. An attempt to examine the possible improvement or suitable application of these heavy oils led the authors to develop a synthetic method for producing a new type of cold-rolling lubricant.

There appear to be no published articles on roll oils used in steel mills that present in detail either the method of manufacture or the materials used in the lubricant composition. There are, however, a number of brief reports on rolling-oil compositions, among which the following examples will illustrate the diversified nature of lubricant composition:

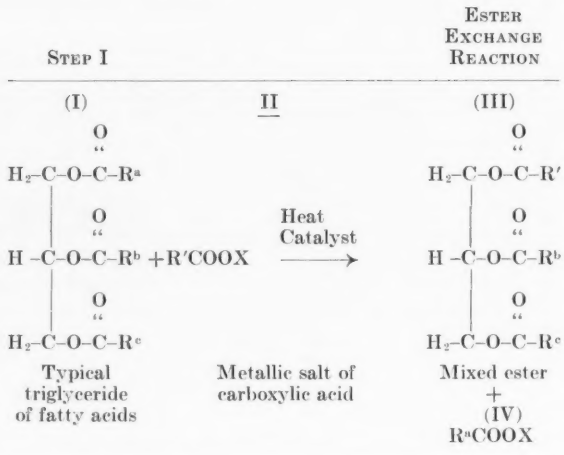
Banner and Markley (4) suggested the use of hydrogenated cottonseed oil as a cold-rolling oil. Pack and Krouert (5) described a tar-emulsion composition for cold rolling of metals. Kingerly (6) recommended an extreme pressure lubricant for the cold rolling of steel. Kingerly's composition consisted of a mixture of tritolyl phosphate, lorol-phosphate, and sulphonated castor oil dissolved in kerosene; 2 to 5 per cent of this mixture, when dissolved in mineral oil, was considered suitable for cold reduction of steel strip. Right (7) has patented an oil composition comprising polymeric homologous compounds of high molecular weight characterized by structures of long chains of saturated carbon atoms of which a number have a C-C link to a recurring organic radical, such as a polybutylene of high molecular weight. Fochtman (8) suggested processing animal fats to obtain better grades of greases and tallow as such for cold reduction of steel. Johnson (9) observed that palm oil and modified tallow have the best lubricity, pure fatty acids the second best, various proprietary roll oils the third best, and petroleum the poorest. The relative lubricity of these lubricants was measured by a simple wire-drawing setup. Palm oil, iron stearate, modified tallow containing 10 per cent free fatty acids, and a lubricant containing fatty acid retained their lubricity at temperatures higher than 300 F. Rocchini and Neely (10) claimed that chlorinated hydrocarbon and organic phosphates —for example, diphenyl-mono (P-or O-chlorophenyl) phosphates—when mixed with petroleum lubricating oils produce improved lubricants for the cold working of metals.

Presented at the 15th ASLE Annual Meeting in Cincinnati, Ohio, April, 1960

In the United States in 1930, Castle (11) tried palm oil on the then-new 5-stand tandem mill. Mineral oil formulas suggested by major oil companies had proved unsatisfactory. Until World War II, imported palm oil held a unique position as the standard cold-rolling lubricant. In 1946, a project was started (12) to investigate possible alternative materials available in fat industries to replace palm oil. Since then, fatty substances such as beef tallow, cottonseed oil, and others, with suitable modifications, have been successfully replacing palm oil in several steel mills. Yet with the mechanical improvements and the increased production rate of high-speed tandem mills, with rated capacity of 7000 fpm, two specific trends in current roll-oil development are evident. By the improvement of refining methods and by the development of derivatives in the fat industry as well as by the use of valuable additives, the roll-oil manufacturers are attempting to present lubricants not only "just as good" as palm oil but definitely superior. Complementing this, the steel industry is attempting a greater understanding of the value of lubrication in modern machinery.

SYNTHESIS

The process of manufacturing these lubricants consists essentially in treating fat and olefin-polymer oil catalytically in such a manner that the final lubricant will contain several types of natural free fatty acids, released directly in the bulk lubricant composition. The mechanism of such a process may be explained as follows:



Depending on the experimental conditions, R^b, R^c, or both could be replaced by R′, and an equilibrium would be established fixing their relative amounts in the final product.

Step II

Product of Step I + Olefin Polymer or Mineral oil —(Heat, Catalyst)→ Copolymer Lubricant

IV of Step I would hydrolyse to R^aCOOH in Step II. By controlling the conditions of the reaction, it would

TABLE 1.—Experimental Verification of Lubricant Synthesis

EXPERIMENT NO.	REACTION		PRODUCT	RESULT 4-BALL TORQUE TEST	REMARKS
1-a	Fat + R′COOX	heat → agitation	A^1	Non-uniform	No ester exchange
1-b	Fat + RCOOX	heat → catalyst #1	A^2	19-20 millimeters*	Ester exchange
2	Polymer oil + R′COOX	heat → catalyst #1	B	Chatter	Cracking of polymer and hydrolysis of ester
3	Mineral oil + R′COOX	heat → catalyst #1	C	Chatter	Cracking of polymer and hydrolysis of ester
4	Product A^2 + Polymer oil	heat → excess catalyst #2	D	Chatter	Excessive side reactions
5	Product A^2 + Polymer oil	heat → catalyst #2	Lubricant #1	8 millimeters	Ester exchange occurs and free fatty acids are released
6	Product A^2 + Mineral oil	heat → catalyst #2	Lubricant #2	7 millimeters	Ester exchange occurs and free fatty acids are released

*Millimeters of deflection of dynamometer indicator.

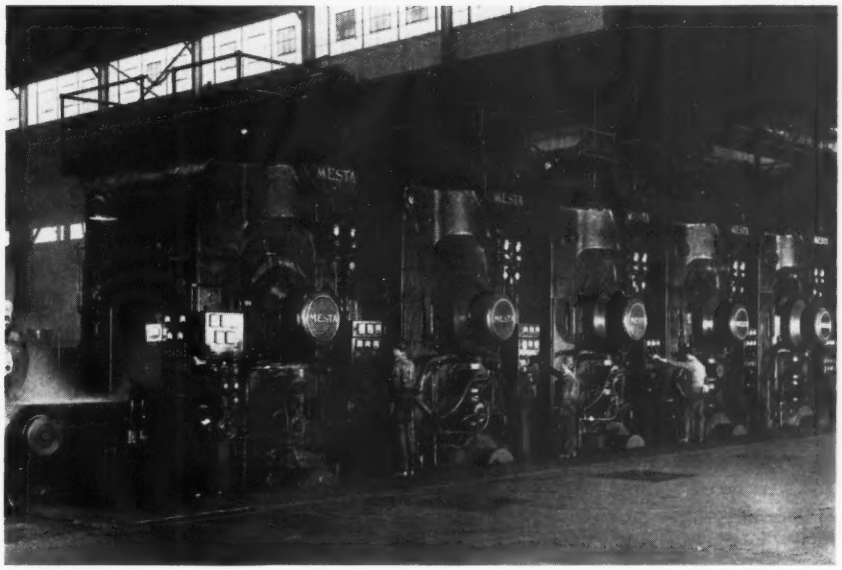


Fig. 1. Five-stand tandem cold reduction mill.

be possible to produce within the lubricant controlled amounts of mixed esters, saturated and unsaturated free fatty acids or their esters so that adequate lubricity could be developed. Further, it may be expected that such a lubricant will provide two specific characteristics:

1. An adequate hydrodynamic factor attributable to the well-dispersed hydrocarbon material.
2. A polar function to satisfy boundary lubrication conditions by virtue of the lubricant's having free fatty acids or their esters — new mixed esters that would be quite different from the original triglycerides of fatty acids.

This scheme of synthesis was experimentally verified; typical results are given in Table 1. The experimental results shown in Table 1 indicate that the carrying out of Step I or Step II independently will result in products that suffer from lack of lubricity. When the suggested scheme of synthesis is carried out properly, lubricants of adequate quality will be produced. The lubricants according to experiments 5 and 6 were made both in laboratory scale and in pilot-plant scale and were tested for lubricity.

EVALUATION

Analysis of Typical Olefin-Fat Copolymer

Melting point	33.3 C
Free fatty acids	2.9
Acid No.	5
Flash point	232.2 C
Fire point	315.6 C
Saponification value (ASTM D 94-28)	140

4-Ball Torque Test

Evaluation of the new lubricant materials appears to be difficult, because conventional lubricant-testing methods do not predict the behavior of lubricants on the cold-reduction mill of the steel industry. Consequently, each new lubricant formulation must be evaluated by actual mill trial, which not only is expensive and time-consuming but invariably results in appreciable loss or even in damage to mill equipment. Therefore, a functional testing method specially suitable for

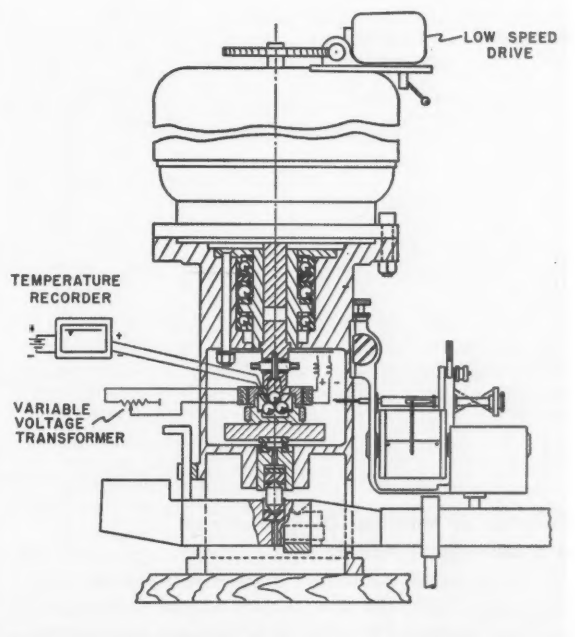


Fig. 2. Cross sectional view of modified 4-ball EP tester.

cold-reduction lubricants has been adopted. This method is a modification of the conventional 4-ball extreme-pressure torque test. In a conventional 4-ball tester, a half-inch steel ball is rotated upon three similar balls, which are clamped in a stationary position. The 4-ball tester provides three points of contact in contrast to the line contact that usually exists in the case of other testing machines. To simulate the actual conditions of speed and extreme pressure on the mill rolls, the following modifications are made:

1. Reduction of speed of the rotating metal ball to 0.3 revolution per minute.
2. Increase of the testing load on the lever arm to about 1100 kilograms, so that the pressure at the point of contact would be approximately 1,000,000 pounds per square inch.
3. Control of temperature of the ball pot, to permit testing the lubricant at controlled elevated temperatures representing mill operation conditions.

Torque values of rolling lubricants determined under the above conditions have been claimed to correlate well with their actual performance on the mill. According to this test, the torque value is indicative of the lubricating quality of the material and the behavior of the torque during a 900-second run is a measure of the film characteristics of the lubricant. Typical results obtained on this machine are as follows:

Water	11 to 47 millimeters*	Nonuniform
Palm oil	9 to 22 millimeters	Nonuniform
Optimum roll oil	8 millimeters	No change in 15 minutes

* The millimeter values represent movement in millimeters of indicator needle on the dynamometer, which responds to the relative torque due to friction developed in the 4-ball machine.

TABLE 3.—4-Ball Torque Test Results

Spring Constant 1.14 kg per mm Sample Lubricant-1		(.3 rpm) Lever Arm Kg. 1100	
Lubricant no. 1, 5% oil—95% water		Lubricant no. 2, 100% oil	
Time (sec)	Test 1 mm	Test 2 mm	Test 3 mm
		Room temp.	at 140 F
100	7	8	9
200	7	8	8
300	7	8	8
400	7	8	8
500	7	8	8
600	7	8	8
700	7	8	8
800	7	8	8
900	7	8	8
Avg mm	7	8	8.1

Behavior of Modified Olefin Polymer in a Laboratory Rolling Mill

After initial evaluation in the 4-ball extreme-pressure tester (13), the lubricant developed from copolymerizing animal fat with hydrocarbons was further evaluated in a laboratory mill (14).

A brief discussion of the operation of the mill and the method of testing is pertinent here.

Not only the type of oil but the amount of it present in the roll bite determines the way in which it lubricates the rolling process. For the fat-based lubricants used on tandem mills, the maximum amount of oil that will pass through the roll bite, no matter how much of it is on the entering strip, is about 15 microinches for polished rolls and smooth low-carbon strip. If, however, an inadequate supply of oil is available on the strip and rolls as they come together, the oil film is thinner and lubrication suffers. On a mill where the oil is supplied by a flood of dilute oil suspended in water, the amount of oil that will leave the suspension and "plate" onto the metal, in the very short time available between roll stands, is a critical factor.

For these reasons, it is desirable to run the laboratory mill in at least two ways for any oil. First, a length of strip is heavily coated with the oil and run off. Second, a length is solvent-coated with perhaps one microinch of oil, which has trivial lubricating value but presents a standard surface. It then enters the mill through a trough about four inches long, filled with oil suspension being pumped at a reasonable velocity. This emulsion flows onto the entry side of the rolls, depositing some useful oil on them. In either case, the strip is preheated to about 80 C on the way to the mill.

With the laboratory mill running at 1000 feet per minute, the data obtained appear to be in excellent agreement with the performance of oil on commercial tandem mills. Both the fundamental lubrication ability of the oil and the ability of a given suspension of the oil to put the oil onto the metal surfaces are evaluated.

For the runs discussed here, low-carbon steel strip, 0.0063 by 0.250 inch, was rolled at 1000 fpm. Rolls and oil suspension were at 50 C. "Load" is the total vertical force applied to the upper roll. Coefficients of friction are taken from a graphical solution of the equations of Stone and Greenberger (15). Lubricant No. 1 was compared with a costly animal-fat commercial lubricant and with Lubricant No. 2, which is similar to Lubricant No. 1 but processed somewhat differently. Table 4 indicates that in all tests the coefficient of friction was 0.043 or less, and predominantly 0.035 or less.

For comparison, a straight mineral oil of reasonable viscosity, say from 200 to 600 SSU at 100 F, when tested under the above conditions, would not give a coefficient of friction under approximately 0.05.

Though the variations in performance appear to be small, there can be no doubt that the copolymer lubricants made by the described process come extremely close to the more costly commercial products.

DISCUSSION

At present, not much information appears to be available from any program of detailed experiments to determine the dependence of the physical properties of a lubricant on pressure and temperature. Such information would help to elucidate unexplained results in industrial and laboratory tests and would lead to a closer insight into the real requirements for lubricants in metal-forming processes employing modern cold-rolling machinery.

Lubricants employed in the tandem rolling-mill are subjected to extremely high pressures, and it is

TABLE 4.—Results of Laboratory Mill Test

ROLL-OIL TYPE	METHOD OF APPLICATION	LOAD (LB)	EXIT GAUGE	COEF FRICTION
Polymer Lubricant No. 1	Suspension	3480	0.0044	0.043
"	Precoat	3400	0.0040	0.033
"	Suspension	4220	0.0033	0.035
"	Precoat	4200	0.0031	0.032
Polymer Lubricant No. 2	From suspension	3440	0.0043	0.041
"	Heavy precoat	3400	0.0038	0.030
"	Suspension	4220	0.0033	0.035
"	Precoat	4200	0.0031	0.032
Animal Fat with Emulsifier	Suspension	3460	0.0043	0.040
"	Precoat	3380	0.0039	0.030
"	Suspension	4200	0.0033	0.035
"	Precoat	4200	0.0032	0.033

relevant to ask what happens to their physical properties at these pressures. Reports are few on the viscosity of liquids at extreme pressures, and possibly the fact that the viscosity values (when judged at atmospheric pressure) bear no relation to the frictional behavior in the roll gap may be explained by the fact that some lubricants are more affected than others (16). Thus, probably surface activity of lubricant material on the metal surface has a predominating influence.

A good lubricant, however, should provide a sufficiently thick film and at the same time, by boundary protection, prevent excessive welding of the deforming metal strip. The synthetics produced from olefin oil of different viscosities and different degrees of unsaturation differed in their relative values of coefficient of friction. The coefficient of friction was higher in the case of a less viscous lubricant if one did not consider experimental error in the laboratory mill test.

In conclusion, in the present investigation an attempt has been made to copolymerize fat and hydrocarbon oil to produce synthetics that are suitable for lubrication of cold-reduction machinery. At best, a new technique and approach have been suggested, and it is up to the lubricant manufacturers and metal processors to judge the merits of this study.

The whole key for stepwise development of these synthetics was in the 4-ball torque tests (see Table 1).

Further, it appears to be established that considerable screening of roll oils may be effected by using the 4-ball extreme-pressure tester and the modified procedure for rolling lubricants. Lubricants having saturated and unsaturated hydrocarbon oils and nonhomogenous compositions are easily screened out in the 4-ball tester, which will either chatter or show erratic values of torque during the test period. It is also indicated that mixtures of higher fatty acids may be better than stearic acid alone, even in the presence of excessive fatty esters and hydrocarbons.

ACKNOWLEDGMENT

The author wishes to express his thanks to the staff of the Lubricants Laboratory, National Tube Division, United States Steel Corporation, and to S. Rodman of Allegheny Refining Company, Verona, Pa., for their kind assistance in the lubricant evaluation.

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Operating Characteristics of Positive Control

FLAT BACK BEARING

for Railway Cars

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Assistant Chief Engineer, American Brake Shoe Co., St. Louis, Mo.

For railroad car application, the flat back journal bearing is presented as an improvement over the presently used steeple back bearing design. The performance of the bearing assembly is improved using the latest design of flat back bearing as it, (a) restricts relative motion between the journal and the journal box, keeping the journal seal surface in contact with the sealing member, and, (b) increases resistance to bearing assembly upset due to impact and braking loads. This is accomplished by the flat top of the bearing, the decreased clearance between the bearing and the journal box, and the longer arc of bearing contact on the journal.

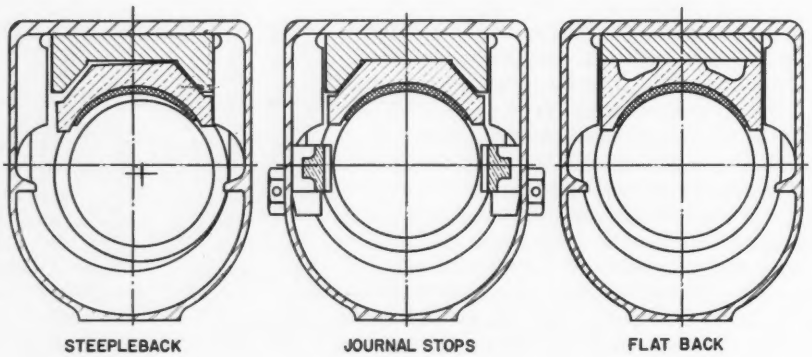

Fig. 1. Cross-section of Three Types of Journal Boxes

The importance of restricting the fore and aft movement of the journal in a journal box assembly has been proven in actual service to be an outstanding factor in improved journal bearing performance. This movement is the result of brake application and accelerating and decelerating forces, which unless restricted, adversely affects the function of the journal box rear seal, the oil wicking media and proper seating of the bearing to maintain film lubrication. The flat back bearing has been proven to be a simple and economical means of controlling this movement, thereby eliminating the need for journal stops or similar accessories that would be necessary with the present steeple back bearing. The positive control flat back journal bearing is a modification of the steeple back design having the top surface flat the full width of the wedge, and sides extended, increasing journal thrust surface, and reducing side clearance in box.

The purpose is to restrict movement of the axle within narrow limits as caused by brake pressure against the wheel, coupling shocks, and the accelerating and decelerating forces that tend to lift the standard steeple back bearing from the journal and also tilt it in the wedge fit, see Fig. 1.

Presented at the 15th ASLE Annual Meeting, Cincinnati, Ohio, April 1960.

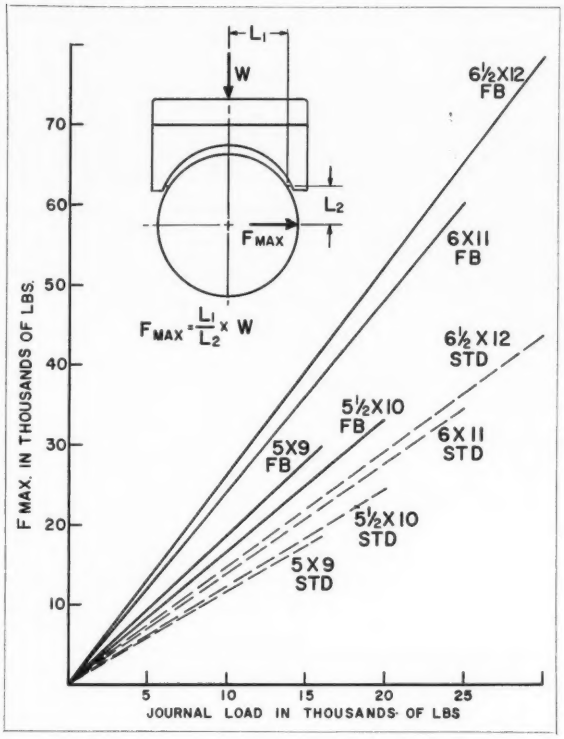

Fig. 2. Journal Load vs Side Thrust Force

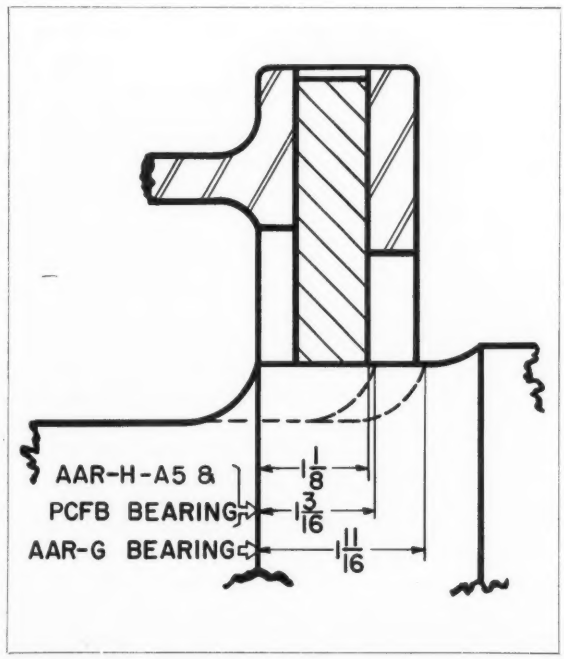

Fig. 3. Dust Guard Position on Axle

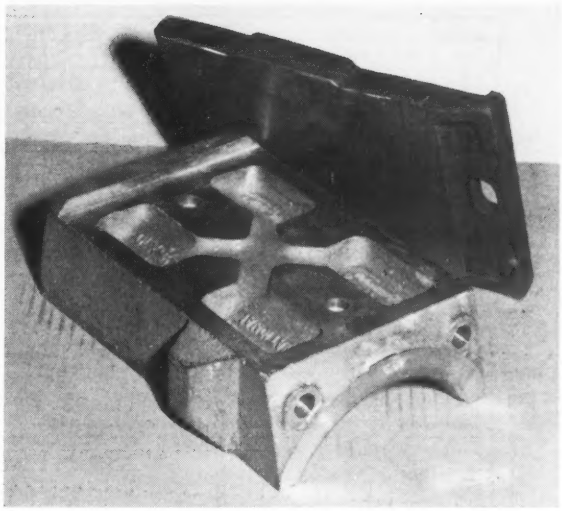

Fig. 4. Flat Back Bearing and Wedge

The sides of the flat back bearing are extended to a maximum height that can be assembled in the journal box. This extended height provides increased arc of bearing contact with the journal for side thrust and doubles the area of contact against the stop column face in the journal box.

Fig. 2 shows the maximum calculated impact force that can be tolerated with the bearing in contact with the journal. Impact forces above this amount would displace the journal in respect to the bearing and wedge. This shows a 35% to 75% increase in impact force that can be withstood by the flat back bearing over the steeple back bearing.

TABLE 1.—Comparative Bearing Arc and Weights of the Bearing and Wedge

SIZE JOURNAL (INCHES)	BEARING ARC (DEGREES)		BEARING WEIGHT	WEDGE WEIGHT
	STEEPLE	FLAT	(1)	(1)
5 x 9	102	124	1.32	.80
5½ x 10	104	120	1.37	.74
6 x 11	112	134	1.36	.76
6½ x 12	112	138	1.29	.77

(1) Multiply the steeple back weight by this decimal fraction to obtain weight of flat back bearing.

The flat back bearing length is increased ¼ inch and lateral movement reduced on the axle collar end from ¾ inches to ¼ inch and on axle fillet end from ¼ inch to 5/32 inch over the AAR-G bearing. This reduced lateral movement is essential to the satisfactory performance of the dust guard and reduction of end wear on the lubricating pads.

Fig. 3 illustrates the relative position of the dust guard on the axle, with length of journal increased 11/16 inch over standard length as permitted under Rule 85 (1) and with bearing worn ¼ inch at one end permitted under Rule 66 j-2 (2). This extreme condi-

JOURNAL SIZE	DIMENSIONS OF BEARINGS															FIN. WGT. BRG
	A-1	A-3	A-5	B	C	D	E	F	G	H	J	K	L	M	N	
5X9	5.015	4.890	4.765	8 3/4	5 5/8	2 15/16	4 1/4	7/8	1 1/8	2 5/8	3 1/4	1 5/8	9/16	9/16	3 5/16	25 1/2
5 1/2 X 10	5.515	5.390	5.265	9 3/4	6 1/8	3 7/16	4 3/4	7/8	1 1/8	2 5/8	3 1/2	1 3/4	5/8	9/16	3 7/16	32 1/2
6X11	6.015	5.890	5.765	10 3/4	7 1/8	3 1/2	5 1/4	1	1 1/4	3 1/4	3 3/4	2	3/4	9/16	3 13/16	47 1/2
6 1/2 X 12	6.515	6.390	6.265	11 3/4	7 5/8	4	5 3/4	1 1/8	1 3/8	3 5/8	4	2 1/2	3/4	9/16	4 1/16	58

JOURNAL SIZE	DIMENSIONS OF WEDGES								
	P	Q	R	S	T	U	V	W	X
5X9	8 21/32	5 5/8	9/16	6 3/4	1 3/8	3 11/16	3 19/32	2 3/4	1
5 1/2 X 10	9 23/32	6 1/8	5/16	6 3/4	1 7/16	4 3/16	4 3/32	2 3/4	1
6X11	10 23/32	7 1/8	5/16	7 3/4	1 7/16	4 11/16	4 19/32	2 7/8	1 1/8
6 1/2 X 12	11 23/32	7 5/8	5/16	8 1/4	1 7/16	5 3/16	5 3/32	3 3/8	1 3/8

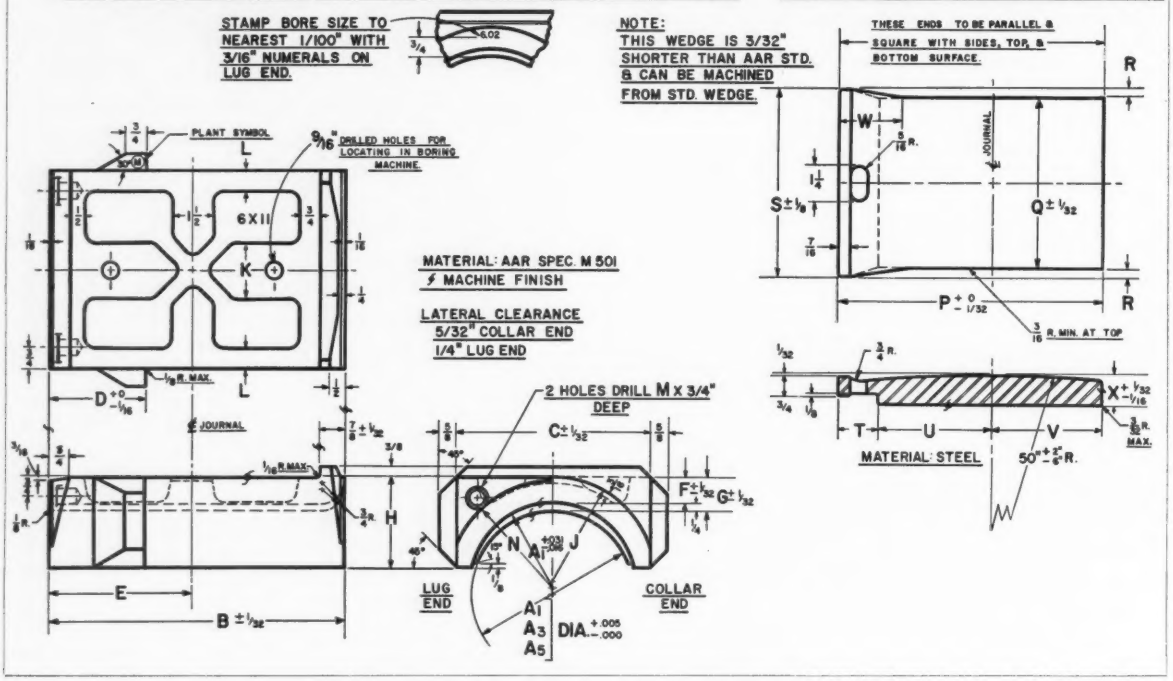
STAMP BORE SIZE TO NEAREST 1/100" WITH 3/16" NUMERALS ON LUG END.
NOTE: THIS WEDGE IS 3/32" SHORTER THAN AAR STD. & CAN BE MACHINED FROM STD. WEDGE.
THESE ENDS TO BE PARALLEL & SQUARE WITH SIDES, TOP, & BOTTOM SURFACE.
PLANT SYMBOL
9/16" DRILLED HOLES FOR LOCATING IN BORING MACHINE
6X11
MATERIAL: AAR SPEC. M 501
MACHINE FINISH
LATERAL CLEARANCE
5/32" COLLAR END
1/4" LUG END
2 HOLES DRILL M X 3/4" DEEP
JOURNAL
LUG END
COLLAR END
DIA. +.005 -.000
MATERIAL: STEEL
3/16 R. MIN. AT TOP

Fig. 5. Flat Back Bearing and Wedge—Detail

tion would permit the dust guard seat on the axle to be out of the dust guard, allowing it to drop on the journal. It is doubtful that any further reduction in lateral would be advisable and any change to correct this condition would be required in Rule 85. The calculated lateral conditions are shown in Table 2.

TABLE 2.—Calculated Lateral Conditions

CONDITION	AAR-G BEARING	FLAT BACK BEARING
Nominal Lateral Clearance	3/4	1/4
Max Journal Length Rule 85	11/16	11/16
Max Bearing End Wear Rule 66	1/4	1/4
Total Lateral Clearance	1-11/16	1-3/16

Application of the flat back bearing and wedge is the same as the steeple back bearing and wedge. For convenience of handling the bearing, in and out of the journal box, two drilled holes are provided in the end for inserting a fork tool made from ½ inch round bar steel. The flat back bearing was first developed about 30 years ago for interurban transit cars. In this service, the accelerating and decelerating forces, with single brake shoe per wheel, resulted in extremely poor bearing performance. The flat back type bearings are still in use today on existing lines and are shown in Engineering Manual of American Transit Association (3). The first application in railroad service was about 20 years ago by a midwestern road, for head end passenger train cars with single shoe brakes. Following this an eastern railroad adopted the bearing for a series of baggage-express cars. In both instances, the bearings are still performing satisfactorily.

The additional cost of flat back over standard steeple back bearings is insignificant when compared to other methods of accomplishing the same end result.

The Association of American Railroads became interested in the flat back bearing in 1950 (4). The AAR Subcommittee on Journal Bearing Development and Technical Advisory Committee for Railroad Journal Bearing Manufacturers, at a joint meeting in St. Louis, on Oct. 12, 1951, initiated a road test of a flat back bearing AAR Dwg. "X" dated Nov. 13, 1951. The design of bearing tested was modified May 29, 1953, to reduce weight, thereby sacrificing structural rigidity. The results of this test are covered in the 1957 Report of the Committee on Lubrication of Cars and Locomotives Circular DV-1398 page 11. The substance of the report indicated no great degree of superiority in performance due to closing in of the bottom of the bearing of this less rigid design. Current test applica-

tions include 100 car sets of flat back bearings applied in Jan. 1958 in freight service. After 17 months in service the bearings were inspected. The performance was so successful that this railroad extended the application by 1000 car sets. Six other railroads have plans to test the flat back bearing and AAR approval for interchange has been granted for 2500 car sets.

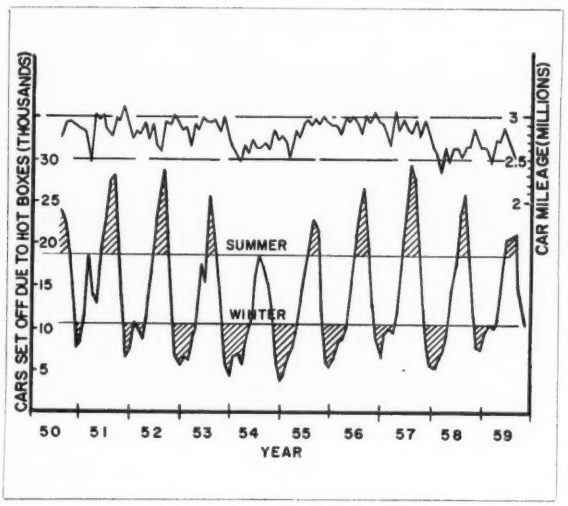

Fig. 6. Cars Set-off due to Hot Boxes

CONCLUSIONS

There are approximately sixteen million Solid Journal Bearings or two million freight cars operating on American Railroad today. It must be conceded that if the improvements which have been developed were installed in these cars, the performance records would be considerably better than they are today.

Hot Box Statistics published monthly do not reflect to any degree the improvements which are being made as a result of mandatory changes.

The successful performance of the solid journal bearing assembly is dependent upon maintaining film lubrication between the bearing and journal (5). This means that

1. The journal must be finished to the required smoothness without nicks or waviness.
2. The bearing and wedge must distribute bearing load uniformly on the journal and the journal side movement must be restricted.
3. The dust guard rear seal must keep the oil in and water and dirt out of the journal box.
4. The lubricating pad must meet AAR Specifications.
5. The journal box oil must meet AAR Specifications.
6. All parts must be properly installed and kept as clean as possible, free from dirt.

BIBLIOGRAPHY

1. Association of American Railroads Interchange Rules Mechanical Division, 1960, p. 196.
2. IBID., p. 164.
3. ATA Engineering Manual—Rolling Stock Division Section E2-34, p. 11.
4. AAR Investigation of Journal Bearing Performance 3rd Progress Report f-3000—Dec. 15, 1950.
5. CDOA—1958 Report of Committee on Car Lubrication, p. 10, Car Department Officers Association.
6. Hanson, M. A.—"Available and Potential Developments in Design for Standard AAR Solid Bearing."

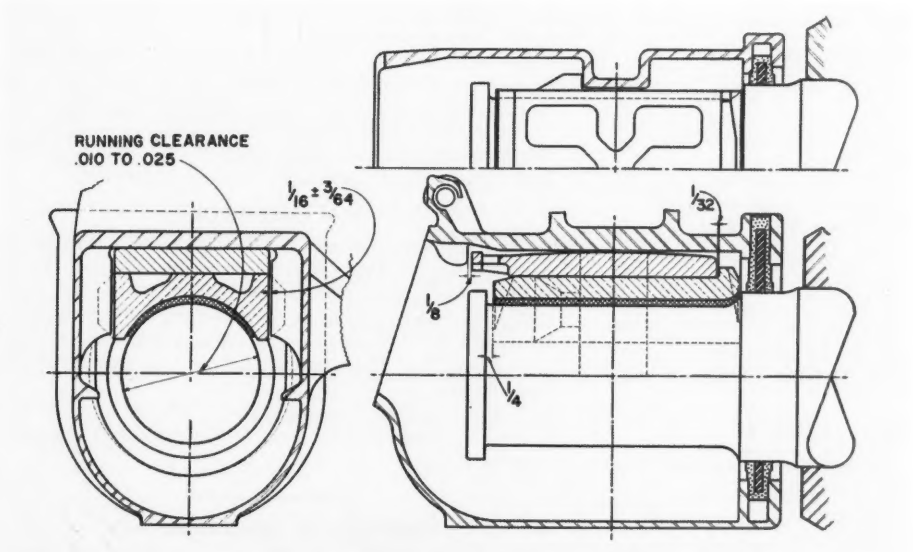

Fig. 7. Flat Back Bearing—Assembly

A *Tentative* Program of the 1961 ASLE ANNUAL MEETING

April 11-12-13, 1961.....Bellevue Stratford Hotel.....Philadelphia, Pa.

The importance of lubrication is becoming more and more apparent to industry in this modern day age. The very existence of today's complex mechanisms is wholly dependent upon proper and scientific lubrication. New techniques as well as new materials are constantly being developed to cope with high temperature problems. Other problems which have plagued the lubrication engineer are being more closely scrutinized in the hope that at last there may be answers to them.

Tuesday, April 11, 1961

Morning—9:00—ASLE Business Meeting

10:00 a.m.—GEARS

Session Organizing Chairman: G. G. Spehn, D. A. Stuart Oil Co.

An Experimental Study of Fretting Wear in Dentul Couplings (Shipboard Couplings), by Robert R. McMath, Technical Operations, Inc.

A New System and Lubricant for Rocket Engine Gear Boxes, by Martin A. Hartman, Rocketdyne Division, North American Aviation.

A New Method for Checking Mechanical Seals and Gear Oil Stability, by Ray I. Potter and Robert Gasvoda, Ford Motor Engineering.

SEAL AND PACKINGS

Session Organizing Chairman: J. A. Heck, Koppers Co.

Materials for Elevated Temperature Piston Ring and Seal Applications, by Glenn F. Hyde and John H. Fuchsluger, Koppers Company.

Mechanical Carbon-Graphite: A Unique Material for Rubbing Surface Applications, by Dimiter Ramadanoff and John H. Sherlock, National Carbon Co.

Welded Metal Bellows Seals, by J. Munley, D. Johnson and R. Blair, Chicago Rawhide Mfg. Co.

PROPERTIES OF LUBRICANTS

Session Organizing Chairman: J. H. Kahlke, Pure Oil Co.

Low Temperature Pumpability of Crankcase Oils, by Robert G. Moyer, Pure Oil Company.

Calculation of Engine Cranking Speed from Engine Oil Viscosity at Low Temperatures, by T. W. Selby, General Motors Research Laboratories.

New Scheme Permits Better Selection of Viscosity Index Improvers for Motor Oils, by J. A. Wuellner, C. G. Brannen, Standard Oil Div., American Oil Co.

Afternoon—1:30

LUBRICATION EQUIPMENT

Session Organizing Chairman: E. J. Gesdorf, Farval Div., Eaton Mfg. Co.

Lubricating Device Capacities, by R. J. Christian, National Tube Div., U. S. Steel Corp.

Individual Pumps Driven from a Common Shaft, by S. L. Leese, Manzel Div., Houdaille Industries, Inc.

What's New in Lubricating Farm Machinery, by J. R. Brehmer, Stewart-Warner Corp.

Oil Fog Lubrication—Past, Present, and Future, by D. G. Faust, C. A. Norgren Co.

Conveyor Lubricators As a Method of Automatic Lubrication, by W. M. Peterson, Olsen Mfg. Co., Inc.

Centralized Lubrication in the Mining Industry, by R. E. Crean, Lincoln Engineering Co.

BEARINGS—HEAVY INDUSTRY

Session Organizing Chairmen: L. E. Hoyer, American Brake Shoe Co. and F. L. Reynolds, Bridgeport Brass Co.

Lubrication of Large Anti-Friction Bearing, by H. B. Yarbrough, Kaydon Engineering Corp.

Design Consideration for Solid Bearings, by B. J. Sexauer, National Bearing Div., American Brake Shoe Co.

Mounting and Lubrication of Anti-Friction Bearings for Optimum Performance, by P. L. Haager, The Timken Roller Bearing Co.

Bearings and Their Lubrication in the Glass Container Plant, by D. E. Grube and A. B. Walker, Owens-Illinois.

Bearing Design and Lubrication in the Flat Rolled Glass Industry, by H. E. Goddard, Blue Ridge Glass Div., American St. Gobain Corp.

PROPERTIES OF LUBRICANTS

Session Organizing Chairman: J. F. Cook, Union Oil Co.

Effect of Lubricant Properties on the Coastdown Characteristics of Instrument Bearing, by P. Lewis and S. F. Murray, General Electric Co.

Application of a New Grease Equation to Velocity Profiles and Lubrication Problems, by A. W. Sisko and L. C. Brunstrum, Standard Oil Div., American Oil Co.

Evaluation of Organo-Selenium Compounds as High Temperature Antioxidants, by R. L. Dueltgen, M. L. Lugasch, and S. L. Cosgrove, Battelle Memorial Institute.

Wednesday, April 12: Morning—9:00

STEEL—GENERAL

Session Organizing Chairman: C. A. Bailey, National Tube Div., U. S. Steel Corp.

Lubricating Problems from Ore to Tin Plate, by A. C. Gartley, Standard Oil Div., American Oil Co.

Fire Resistant Hydraulic Fluids, by S. P. Polack, Bureau of Mines.

Spindle Coupling Lubrication Methods, by John Simon, U. S. Steel Corp.

BEARINGS—ROLLING CONTACT

Session Organizing Chairman: J. C. Lawrence, SKF Industries

Effect of Low Speed Friction on High Speed Bearing Life, by D. W. Criddle and J. Cortes, Jr., California Research Corp.

Lubrication of Bearings with Rocket Propellants, by M. F. Butner and J. C. Rosenberg, Rocketdyne Div., North American Aviation.

Measurements of Lubricant Film Thickness and Elastic Deformation at Rolling Contacts by an X-ray Method, by L. B. Sibley and F. K. Orcutt, Battelle Mem. Inst.

The Effect of Penetration and Thickener Content on the High Temperature Performance of Greases in Ball Bearings, by A. A. Schwartz, General Electric Co.

MACHINE TOOL

Session Organizing Chairman: D. R. Skudstad, Gisholt Machine Co.

Organizing a Plant Lubrication Program, by H. J. Cohen, Wire and Cable Div., Northern Electric Co., Ltd.

A Mechanical Problem in the Lubrication of High Speed Gears, by W. F. Diehl, General Motors Technical Center.

Improve Your Machine Tool Lubrication, by H. Tiffany, Sun Oil Co.

A Machine Tool Users Opinion of the Standardization of Specifications of Lubricants, by John Welsh, Caterpillar Tractor Co.

Afternoon—1:30

LUBRICATION FUNDAMENTALS

Session 1—Session Organizing Chairman: C. W. Nichols, Socony Mobil Oil Co.

Lubrication of Coated Titanium, by R. V. Klint and R. S. Owens, General Electric Company.

On the Theory of Parallel Surface Thrust Bearings and Lubricated Face Seals of Finite Width, by R. A. Stein, Battelle Memorial Institute.

The Abrasive Wear Resistance of Some Bearing Steels, by E. Rabinowicz, L. A. Dunn and P. G. Russell, Massachusetts Institute of Technology.

Session 2—Session Organizing Chairman: W. Philipoff, Esso Research and Engineering Co.

Viscoelastic Effects in Lubrication, by A. H. Nissan, Rensselaer Polytechnic Institute.

Normal Stresses in Lubrication, by Hershel Markovitz, Mellon Institute.

Lubrication with Non-Newtonian Liquids, by H. H. Horowitz, Esso Research & Engineering Co.

BEARINGS—ROLLING ELEMENTS

Session Organizing Chairman: J. C. Lawrence, SKF Industries, Inc.

Detection of Damage in Assembled Rolling Element Bearings, by O. G. Gustafsson and T. Tallian, SKF Industries, Inc.

The Effect of Lubricants on Fatigue Life of Ball Bearings, by E. A. Baniak and G. A. Kohl, Texaco, Inc.

Breakdown of EP Gear Lubricants in Pinion Bearing Applications Operating at Temperatures Above 200°F., by W. E. Ellis, R. L. Hill, and E. M. Downs, Timken Roller Bearing Co.

The Effect of Temperature in Concentrated Contact Lubrication, by F. W. Smith, National Research Council of Canada.

ENGINE LUBRICATION

Session Organizing Chairman: R. A. Carley, Esso Standard Div., Humble Oil & Refining Co.

Comparison of Two Laboratory Test Methods Used to Evaluate the Effect of Oil on the Frictional Characteristics of Silver or Steel, by R. A. Otcasek, Lubrizol Corp.

Radiotracer Study of Piston Ring and Cylinder Liner Wear in a Diesel Engine, by R. B. Price, A. W. Carey, and W. S. Diethorn, Battelle Memorial Institute.

Effect of Detergents and V.I. Improvers on Engine Wear and Friction, by E. H. Okrent, Esso Research & Eng. Co.

Lubricating Oil Requirements of Large Gas Engines, by L. O. Bowman, California Research Corp. and R. S. Ridgeway, Standard Oil of Calif.

Engine Dirt and Its Effect on Engines, by W. E. Thill, Federal-Mogul Bearing.

Some Lubrication Problems in Air Cooled 2-Cycle Engines, by J. W. Savin, Atlantic Refining Co.

Thursday, April 13: Morning—9:00

PANEL DISCUSSION ON STEEL MILL LUBRICATION

Session Organizing Chairman: C. W. Pehle, Jr., U. S. Steel Corp.

Testing of Lubricants and Fire Resistant Fluids, by J. Aarons, National Tube Div., U. S. Steel Corp.

Design and Lubrication of Anti-Friction Bearings, by S. Weckstein, The Timken Roller Bearing Co.

Design and Lubrication of Plain and Fabric Bearings, by B. J. Sexauer, National Bearing Div., American Brake Shoe Co.

Properties of Greases for Steel Mill Lubrication, by E. S. Reynolds, Mobil Oil Co.

Properties of Oils for Steel Mill Lubrication, by J. C. Van Gundy, Texaco, Inc.

Gear Lubrication, by J. J. Stolz, The Tool Steel Gear and Pinion Co.

Steel Mill Lubrication (Lubrication Program and Bulk Grease), by J. Waite, Inland Steel Co.

Steel Mill Lubrication (Seals, Packings, and Automatic Applications), by T. A. Bessent, Bethlehem Steel Co.

BEARINGS—SLIDING CONTACTS

Session Organizing Chairman: P. G. Smith, Oak Ridge Nat. Lab.

An Approximate Analytical Solution for Self-Acting Gas Lubrication of Stepped Section Thrust Bearings, by J. S. Ausman, Autonetics Division, North American Aviation.

The Finite Section Thrust Gas Lubricated Step Bearing, by E. Saibel and T. Toba, Rensselaer Polytechnic Institute.

A Centrifugal Effect Self Acting Thrust Bearing, by F. Osterle and L. Walker, Carnegie Tech.

Fundamental Study of Frictional Behavior of Materials in Sliding Contact in Sodium Environments, by J. W. Kissel, W. A. Glaeser, and C. M. Allen, Battelle Mem. Inst.

GENERAL SESSION

Session Organizing Chairman: R. K. Gould, Texaco, Inc.

Hydraulic Winches—An Evaluation, by W. H. Lewis, Lake Shore, Inc.

Hydraulic Equipment on the Dredge Markham, by J. H. Drucker, Marine Div., U. S. Army Corps of Engineers, and T. F. Carr, Dredge Markham.

Gas Turbines and Fire Resistant Lubrication, by O. M. Fletcher, Tennessee Gas and Transmission Co.

Lubrication Disposal in Reference to Clean Streams, by A. B. Two, Motor Oils Refining Co.

Afternoon—1:30

RAILROAD

Session Organizing Chairman: R. W. Van Sant, Gulf Research and Development Co.

Modern Railway Journal Roller Bearing Grease, by R. Byrne, Association of American Railroads.

Panel Discussion—*Diesel Locomotive Crankcase Oil Filtration*—Panel Members from: Two Railroads, Two Filter Manufacturers, Two Diesel Engine Manufacturers, One Lubricant Supplier.

BEARINGS—SLIDING CONTACTS

Session Organizing Chairman: P. G. Smith, Oak Ridge Nat. Lab.

A Composite Infinite Slider Bearing, by D. F. Hays, General Motors Research Labs.

Levapad Speed Tests, by D. J. Jay and E. H. Fields, Ford Motor Co.

A Method for Predicting Spherical Bearing Life in an Airplane Control System, by W. D. Craig, Gruman Aircraft Engineering Corp.

Some Characteristics of PTFE Fabric Lined Bearings Under High Load and Slow Oscillation, by W. D. Craig, Gruman Aircraft Engineering Corp.

Fringe Areas: *Dry Lubricants or Greases—Design Information*, by G. A. Clark and J. O. Pence, North American Aviation, Inc.

FLUIDS FOR METAL WORKING

Session Organizing Chairman: E. W. Emmerich, Allegheny Ludlum Steel Corp.

Bench Tests Check Speed of Quenching Oils, by G. R. Furman, Texaco, Inc.

Some Aspects of Physical and Chemical Properties of Cutting Fluids, by A. E. Baker, General Electric Co.

STAINLESS STEEL SYMPOSIUM

Cold Drawing of Stainless Tube and Wire, by A. W. Dahl, Amchem Products, Inc.

A Review of Metal Working Lubricants for Stainless Steel, by A. J. Stock, Acheson Colloids Co.

Panel Discussion—F. J. Schmitt—D. A. Stuart Oil Co., L. Salz—Magnus Chemical Co., R. Flinn—J. Bishop and Co., J. E. Anderson—Armco Steel Co.

Lubrication Abstracts

Edited by W. E. Campbell

Selected literature compiled by members of the Technical Committees and Industry Councils of the Society.

By H. C. Rippel, "Design Manual: Bronze Sleeve Bearings," *Machine Design*, v. 31, no. 19, 20, 22-24; September 17, 1959, pp. 173-206; October 1, pp. 141-147; October 29, pp. 135-138; November 12, pp. 170-177; November 26, pp. 132-137. Published in book form by Cast Bronze Bearing Institute, Inc., Evanston, Illinois, 1960.

These are articles on the design and application of 360-degree bronze bearings. Some of the fundamentals of sleeve bearing design are presented for cases of full film, boundary, and mixed film lubrication. Several graphs are included to simplify calculations. The subject of viscosity is treated with formulae an conversion tables included. The various methods of applying lubricants are discussed and specifications given for determining the shape and dimensions of grooves in the bearing surface. The properties of various cast bronze bearing materials are included together with information on bearing fabrication and assembly. *(Abstractor: by H. N. Kaufman)*

W. M. Sterry, "Glass Lubricants Aid High-Temperature Forming," *Metal Progress* v. 77, no. 6, 1960, pp. 110-16.

This is a study of the feasibility of using low melting glasses in molten condition as lubricants during forming of titanium alloys at elevated temperature. Data indicate that good lubrication can be produced over a wide range of temperatures. Lubricants to be used at 1200 to 1500°F, and for hammer forming at 1600°F are discussed. A viscosity test is described which provides data correlating well with lubricating properties. *(Engineering Index Abstract per W. E Campbell)*

Yukio Hori, (University of Tokyo, Bunkyo-Ku, Tokyo, Japan), "A Theory of Oil Whip", *ASME Trans*, Jr. Applied Mechanics, v. 26, Ser. E, no. 2, 1959, 189-98.

Oil whip, defined as a self-excited lateral vibration of a shaft rotating in fluid film bearings, is investigated both theoretically and experimentally. The inherent instability of rotors in previous theories is avoided by assuming zero pressure in those regions where negative pressures are predicted, i.e. in the divergent clearance space. The stability problem is considered in two parts; for small vibrations and for large vibrations. For small vibrations the equations of motion for the rotor are linearized and the Hurwitz stability criterion is applied. (Hurwitz, A., "Ueber die Bedingungen, unter welchen eine Gleichung nur Wurzeln mit negativen reellen Theilen besitzt", Math. Ann., 46, 273-284, 1895). For large vibrations a model is assumed as a rotating cylinder connected to the center of the bearing with a spring so that the natural frequency of the cylinder is equal to that of the rotor. To confirm theoretical results an experimental apparatus is used consisting of a rotor on a light shaft supported by a ball bearing and a journal bearing. Recordings are made using a light source and mirrors. The effect of oil force on whirling, the occurrence of oil whip of high orders, the starting speeds of oil whip, the effect of a blow and the effect of viscosity on stability, and the changes of amplitude with speed are discussed. The conclusions are that a rotor may be stabilized by increasing the eccentricity of the journal and bearing by using a narrower bearing or a less viscous lubricant. Also, when operating at speeds above twice critical, the oil whip amplitude may be damped by increasing the length of the bearing or by using a more viscous lubricant. *(Abstractor: D. F. Hays)*

A. B. Jones (The Fafnir Bearing Company, New Britain, Connecticut), "A General Theory for Elastically Constrained Ball and Radial Roller Bearings under Arbitrary Load and Speed Conditions," *Jour. Basic Engr.* 82, series D, no. 2, 1960, pp. 309-320.

A completely general solution is obtained whereby the elastic compliances of a system of any number of ball and radial roller bearings under any system of loads can be determined. Elastic yielding of the shaft and supporting structure are considered as well as centrifugal and gyroscopic loading of the rolling elements under high-speed operation. The solution defines the loading and attitude of each rolling element in each bearing of the sytsem as well as the displacement of each inner ring with respect to its outer ring. For ball bearings the precise location of the load paths in each raceway are found. Life estimates can be more accurately made since the fatigue effects can be evaluated over known paths in the raceways. The solution, which is accompublished numerically by iterative techniques, has been programmed for an IBM-704 digital computer. *(Abstractor: R. A. Schoeppel)*

O. Holfelder, (Gebr. Sulzer, A.G., Winterthur, Switzerland), "Alternating Load Bearing Test Machine and Testing of Heavily Loaded Sleeve Bearings of Full Size," *Motortechnische Zeitschrift*, v. 20, no. 6, 1959, 173-177 (in German).

Described in detail is a bearing test machine provided with hydraulically generated cyclic loading for the testing of diesel engine sleeve bearings up to sixteen inches in diameter. The test procedure and some of the test results obtained during the five-year service of this machine are presented and discussed. *(Abstractor: George C. Lawrason)*

Patent Abstracts

Compiled by Ann Burchick
Aluminum Co. of America

Water-In-Oil Emulsion Lubricants, Patent No. 2,927,079 (W. F. Jense, J. L. van der Minne, and P. H. J. Hermanie, assignors to Shell Development Co.) A stable water-in-mineral oil emulsion lubricant comprising from 20 to 40 parts of water as the dispersed phase and from 80 to 60 parts of mineral oil as the continuous phase, said emulsion containing dispersed essentially in the oil phase (1) an oil-soluble alkaline earth metal organic sulfonate in an amount of from about 0.05% to about 0.5% by weight of the metal, calculated on the oil phase, and (2) from about 2% to about 5% by weight, calculated on the oil phase, of an alkyl phenol containing from 2 to 40 alkyl carbon atoms so as to prevent phase separation and flocculation.

Grease Compositions Containing Salts of Carboxylic Copolymers, Patent No. 2,929,785 (A. J. Morway, J. H. Bartlett, A. H. Gleason and S. B. Lippincott, assignors to Esso Research & Engineering Co.) A lubricating grease composition comprising a major proportion of a mineral lubricating oil; in the range of 2 to 35 wt. percent of an alkali metal salt of an acidic polymeric material; and in the range of 2 to 6 wt. percent of an alkali metal salt of a low molecular weight acid having in the range of 1 to 5 carbon atoms per molecule and about 2 to 30 wt. percent of an alkali metal soap of a C_{12} to C_{22} carboxylic acid, said soap and said alkali metal salts being heated to a temperature in the range of 400 to 600F. for a time in the range of 0.5 to 5 hours and said acidic polymeric material consisting of a copolymer of one mole of a monocarboxylic alphabeta unsaturated acid having in the range of 3 to 6 carbon atoms per molecule, within the range of 10 to 20 moles of a conjugated diolefin containing in the range of 4 to 10 carbon atoms per molecule; said copolymer being formed by heating the acid and diolefin to a temperature in the range of 60 to 140C. for a time in the range of 1 to 24 hours in the presence of a polymerization catalyst.

Lubricant Additives, Patent No. 2,929,828 (J. O. Smith, Jr. and J. F. Kune, Jr., assignors to Esso Research & Engineering Co.) As a product, an oxygen-containing reaction product obtained by reacting about one mole of an aluminum alcoholate having the formula $Al(OR')_3$ where R' is an aliphatic hydrocarbon group containing 1 to 20 carbon atoms with about 1 to 2 moles of a phospho-sulfurized olefinic hydrocarbon at a temperature between about 150 to 450F. for a period of time between about 0.2 to 10 hours with the removal of alcohol.

Lubricating Compositions Containing Salts of Monocarboxylic Acids and Free Alkalinity, Patent No. 2,930,757 (A. J. Morway, H. F. Lipinski and H. T. Shearer, assignors to Esso Research & Engineering Co.) A lubricant thickener concentrate which comprises about 50 to 75 wt. percent of a lubricating oil having a viscosity in the range of 60 to 2500 S.S.U. at 10F., and about 25 to 50 wt. percent of a mixture of alkaline earth metal salts of low molecular weight monocarboxylic acids having from 1 to 3 carbon atoms per molecule and alkaline earth metal salts of moderate molecular weight monocarboxylic acids having from 7 to 12 carbon atoms per molecule, the mol ratio of said low to said moderate molecular weight acids being in the range of 2:1 to 40:1, said thickener concentrate having a free alkalinity in the range of 1 to 1.8 wt. percent.

Ester-Base Lubricant Containing Anti-Oxidant Mixtures, Patent No. 2,930,758 (R. B. Tierney, R. H. Krug and R. P. Chesluk, assignors to Texaco Inc.) A lubricating oil composition having improved anti-oxidant properties at high lubricating temperatures consisting of an alkyl C_5-C_{10} diester of the dimer of linoleic acid as the base fluid, from 0.5 to 2% by weight of an anti-oxidant combination composed of from 40 to 60% phenothiazine and from 60 to 40% of a mixture of about two parts N-phenyl-beta-naphthlyamine, one part N, N'-diphenyl-p-phenylene diamine, and one part p-isopropoxy diphenylamine, and from 1 to 5 weight percent of di-(o-chlorophenyl) phenyl phosphate.

Synthetic Lubricating Oil Composition. Patent No. 2,929,786 (D. W. Young and R. L. May, assignors to Sinclair Refining Co.) A synthetic lubricating oil composition having a maximum viscosity at −40 F. of about 13,000 centistokes and a minimum viscosity of about 7.5 centistokes at 210 F. and consisting essentially of an oily diester base having a viscosity of about 35 to 250 SUS at 210 F., said diester being of an aliphatic dibasic acid of up to about 12 carbon atoms and an aliphatic alcohol of up to about 12 carbon atoms, and about 20 to 50 weight percent of the polyester produced by reacting in the molar ratio of about 1:1 a material selected from the group consisting of aliphatic dibasic acids of up to about 12 carbon atoms and the lower aliphatic esters therof containing up to about 3 carbon atoms in the ester group polyester having a kinematic viscosity of about 40 to 125 centistokes at 210 F.

Novel Composition of Improved Lubricating Properties Comprising a Fluorochloro Polymer, Patent No. 2,927,893 (D. E. Neunherz, assignor, by mesne assignments, to Minnesota Mining & Manufacturing Co.) A novel lubricant composition of high load-carrying capacity consisting essentially of an admixture of up to about 20 weight percent of said admixture of a liquid open chain telomer of trifluorochloroethylene having between about 4 and about 20 carbon atoms and containing a plurality of trifluoroehloroethylene monomer units and chlorine terminal groups and a liquid linear siloxane polymer selected from the group consisting of methyl phenyl siloxane polymer, methyl p-bromophenyl siloxane polymer, methyl p-chlorophenyl siloxane polymer, methyl m-trifluoromethyl phenyl siloxane polymer, methyl 3,4-dichlorophenyl siloxane polymer, and dimethyl siloxane polymer having a viscosity of at least 10 centistokes at 25 C.

(Continued on page 96)

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PATENT ABSTRACTS

(Continued on page 95)

High Extreme Pressure Grease Compositions, Patent No. 2,956,022 (B. W. Hotten, assignor to California Research Corp.) A grease composition comprising a major proportion of an oil of lubricating viscosity and, in combination, a metal salt of N-alkyl terephthalamic acid containing from 4 to 22 carbon atoms in the alkyl radical and a metal salt of a mononuclear aromatic monocarboxylic acid, wherein the mole ratio of said metal salt of aromatic monocarboxylic acid to said metal salt of terephthalamic acid has a value from 0.1 to 20, and wherein said metal salt of terephthalamic salt is present in an amount sufficient to thicken said oil to the consistency of a grease, wherein the metal in each instance is a metal selected from the group consisting of the metals of Groups I and II of Mendelyeev's Periodic Table.

Lubricating Grease Compositions Inhibited Against Oxidation, Patent No. 2,954,342 (B. W. Hotten, assignor to California Research Corp.) A grease composition essentially of an oil of lubricating viscosity thickened to the consistency of a grease by an organic grease thickening agent and having incorporated therein in an amount sufficient to inhibit oxidation, a trialkylamide of an alkylenediamine tetraacetic acid.

Bacteria Inhibited Soluble Oil Emulsion, Patent No. 2,954,343 (H. J. Pitman, assignor to Texaco Inc.) An improved soluble oil emulsion comprising from about 5 to 100 parts of water to about 1 part of an emulsifiable mineral lubricating oil, and a bacteria destroying and inhibiting amount in about the range 100-1000 parts per million of the said emulsion of 3,5-dialkyltetrahydro—1,3,5—(2H)—thiadiazine—2-thione wherein the alkyl groups have from 1 to 4 carbon atoms.

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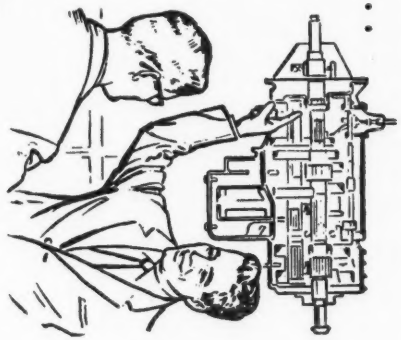

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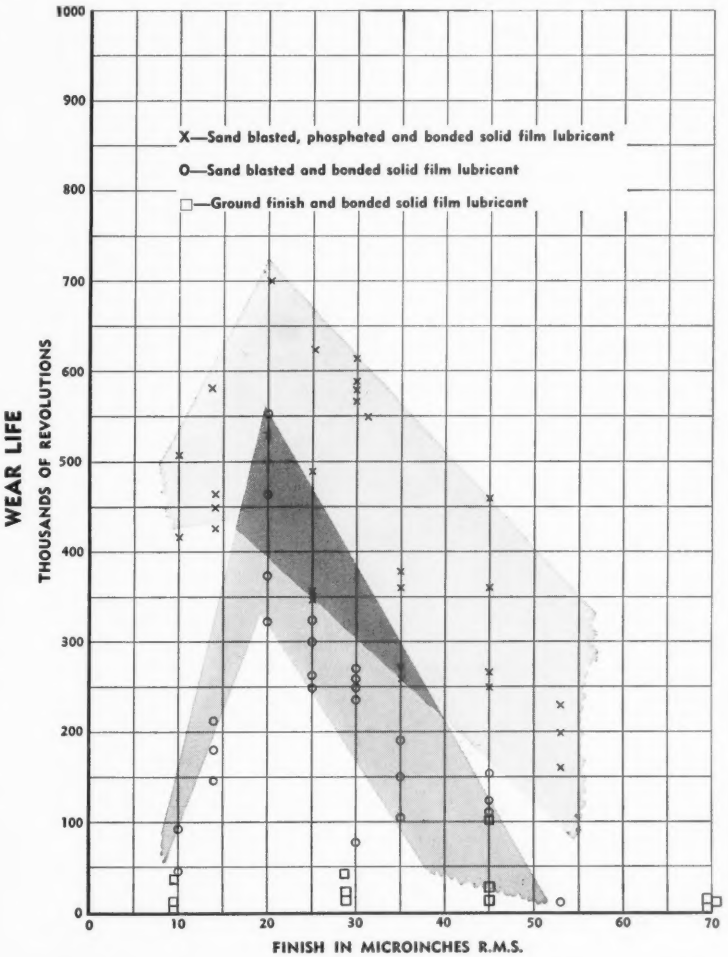

WEAR LIFE VERSUS SURFACE FINISH curves show the significance of surface finish and the methods used to produce it. Tests were run on Alpha Model LFW-1 testing machines. The following key indicates the testing procedures used: X shows results of samples which were ground to 8 to 10 microinches r.m.s. and then sandblasted to finish shown. After sandblasting, these samples were phosphated and then coated with a bonded solid film lubricant; ○ shows the results on samples which were ground to 8 to 10 microinches r.m.s., sandblasted to the r.m.s. finish shown and then coated with a bonded solid film lubricant; □ shows results on a ground surface coated with a bonded solid film lubricant.

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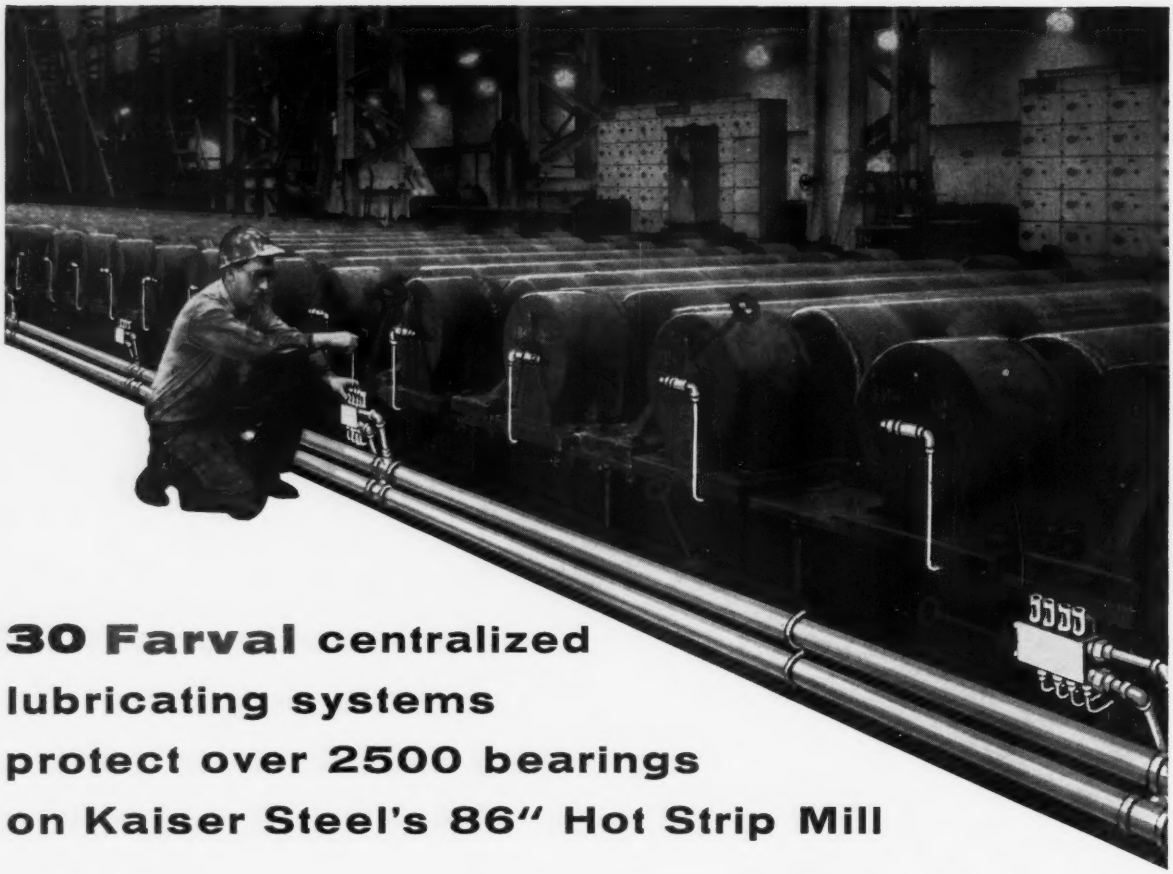

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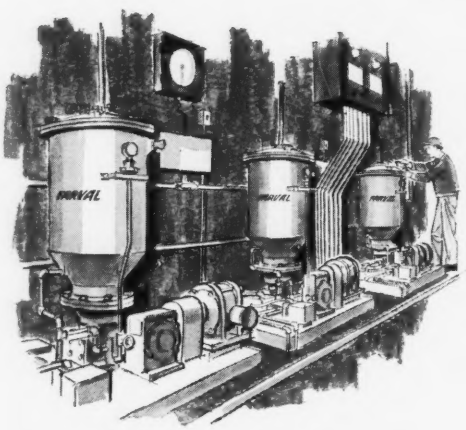

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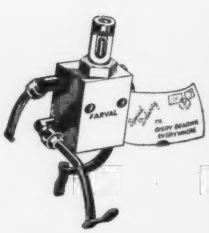

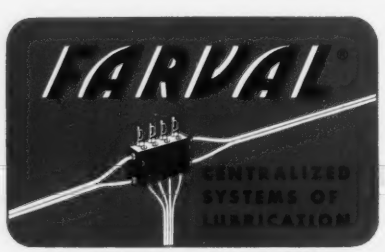

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